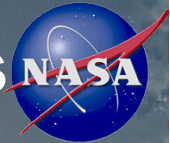


# International Space Station External Payload Accommodations/Interfaces



Earth Venture 2 Pre-Proposal Conference

12 July, 2011

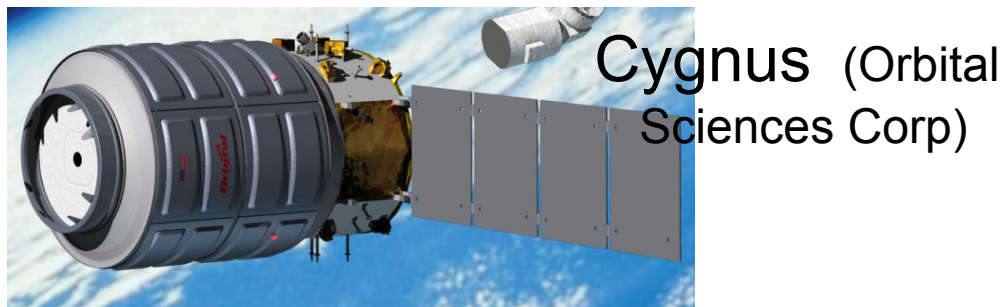


ISS Technology Demonstration Office  
Space Station Payloads Office

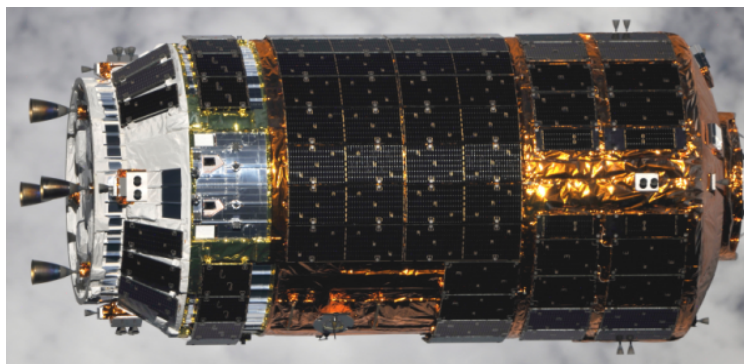




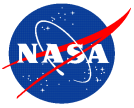
# ISS Cargo/Payload Launch and Return Vehicles



HTV (JAXA)

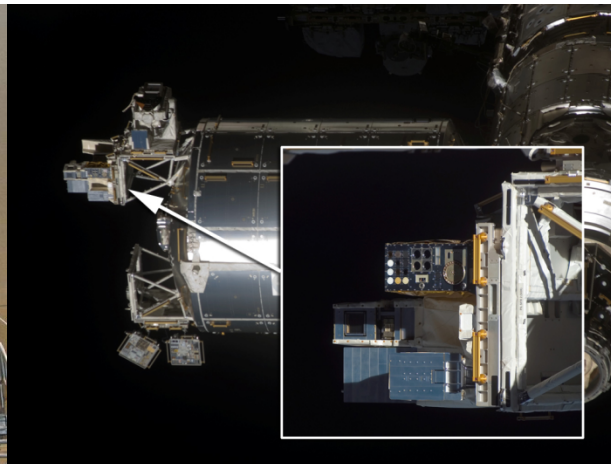
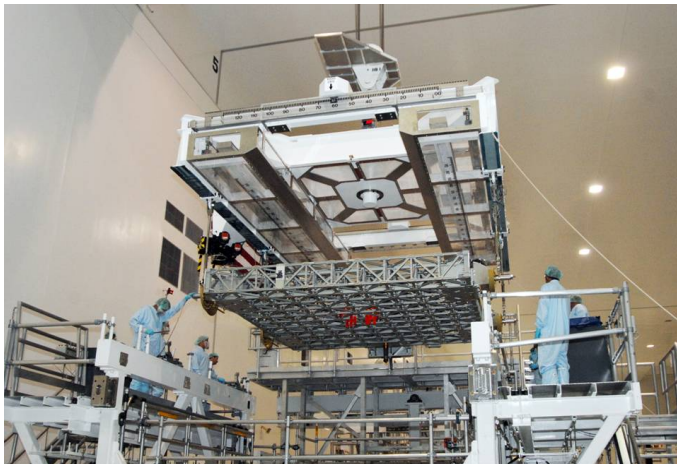
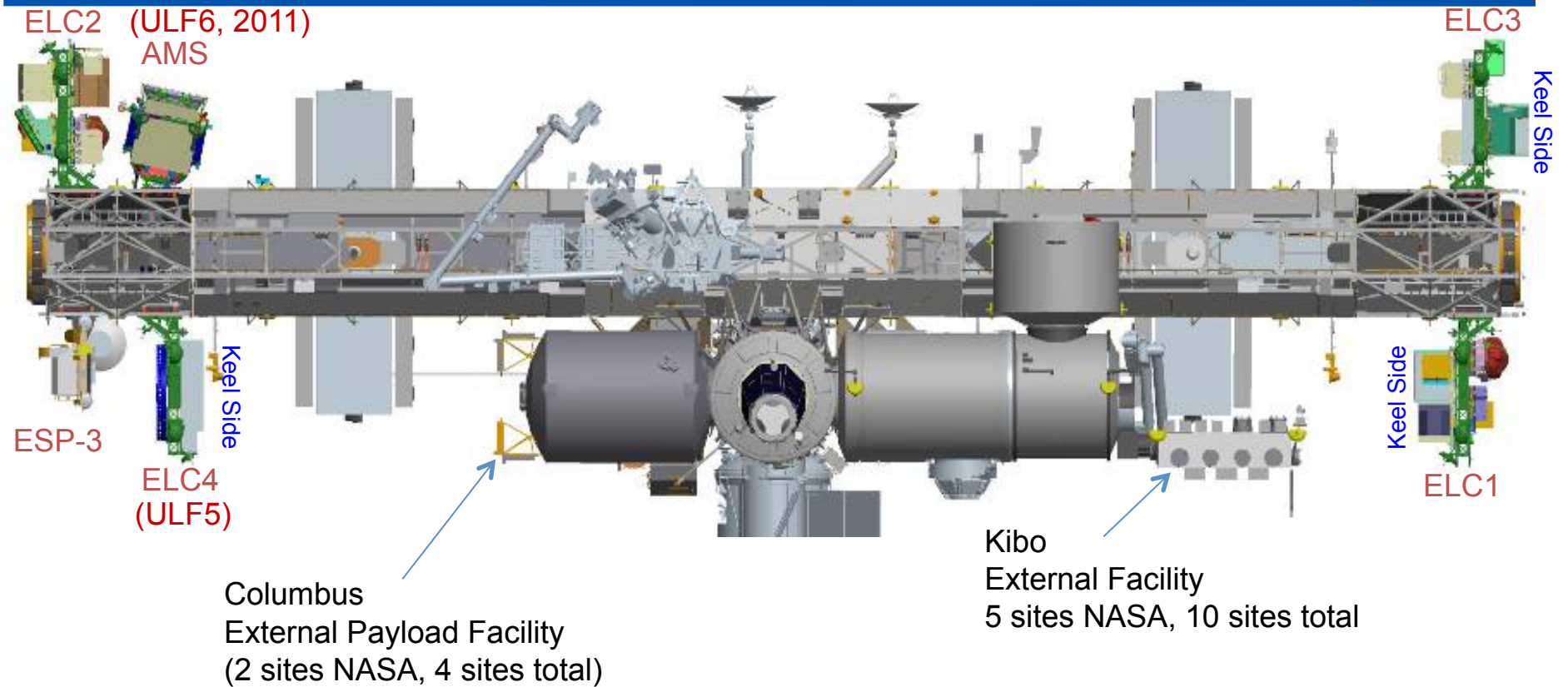


Dragon (SpaceX)

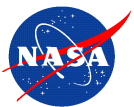


# International Space Station (ISS) External Research Facilities

(ULF6, 2011)







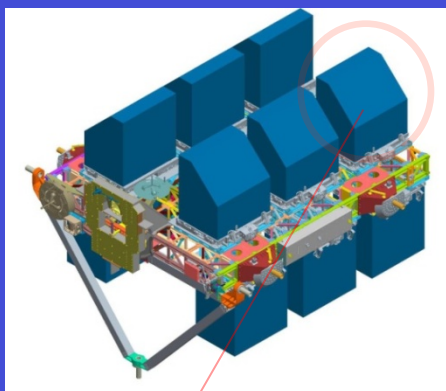
# External Research Accommodations

## Express Logistic Carrier

### ELC Single Adapter Resources

(2

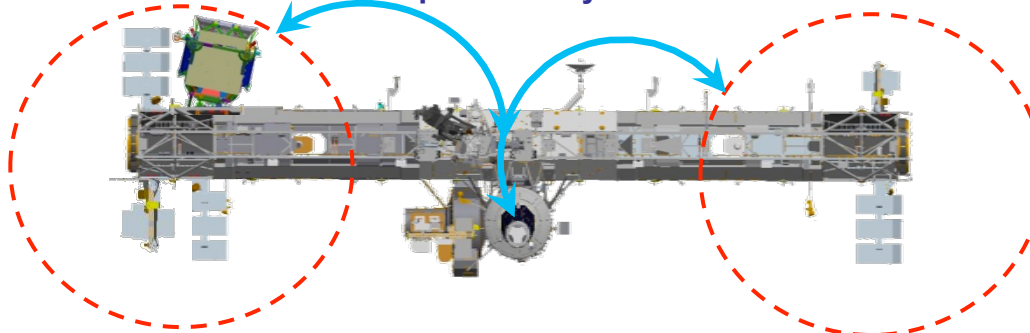
NASA payload sites per ELC)



Mass capacity	227 kg (500 lb)
Volume	1 m <sup>3</sup>
Power	750 W, 113 – 126 VDC; 500 W at 28 VDC/adaptor
Thermal	Active heating, passive cooling
Low-rate data	*1 Mbps (MIL-STD-1553)
Medium-rate data	*6 Mbps (shared) - Return link (payload to ISS) only
Sites available per ELC	2 sites
Total ELC sites available	8 sites

Research Payload ExPA  
(see next chart)

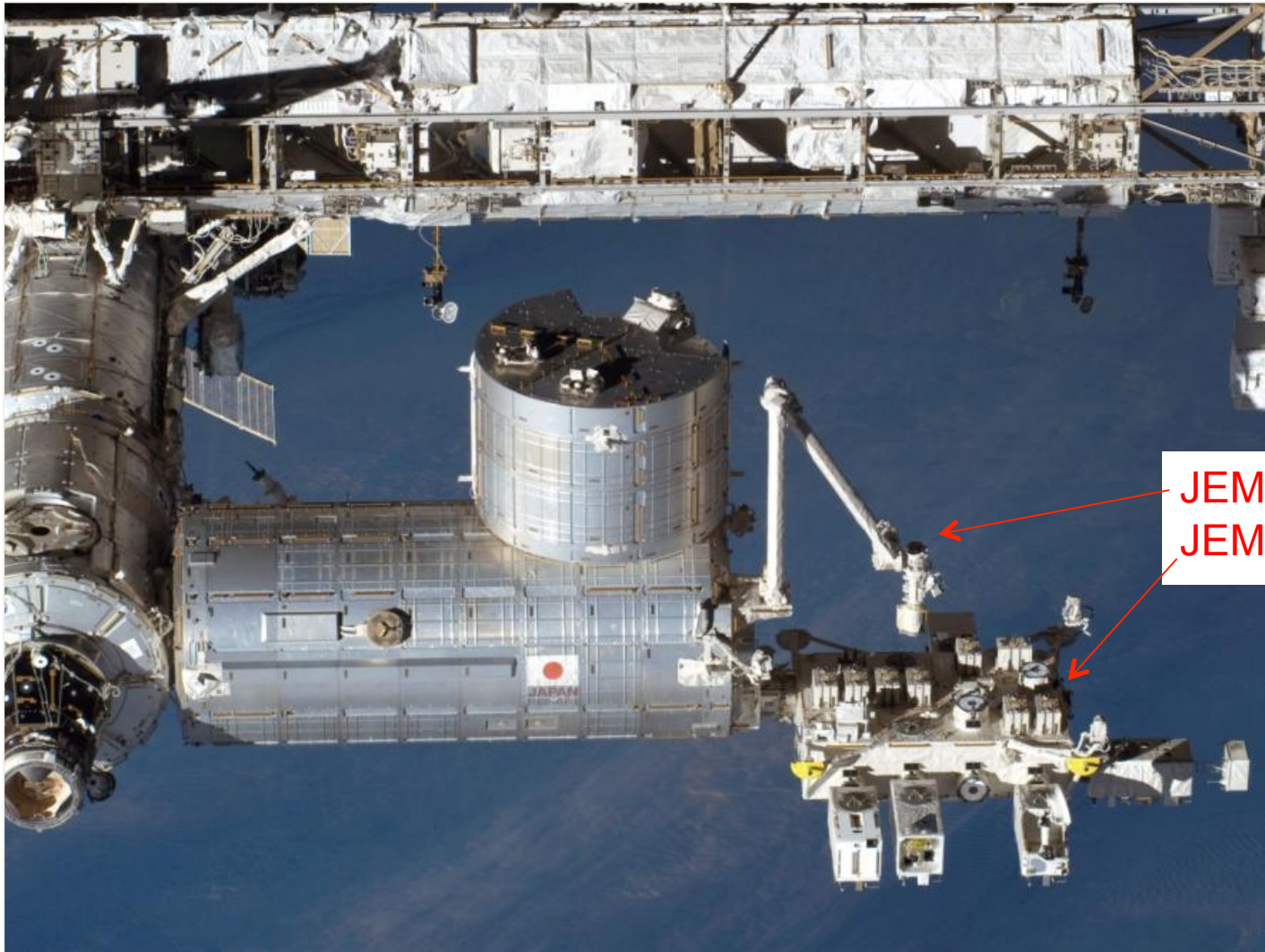
**Proposed C&DH Enhancement to each Research Payload site**  
**100 Mbps Two Way wireless LAN**







# Japanese Experiment Module - *Kibo*

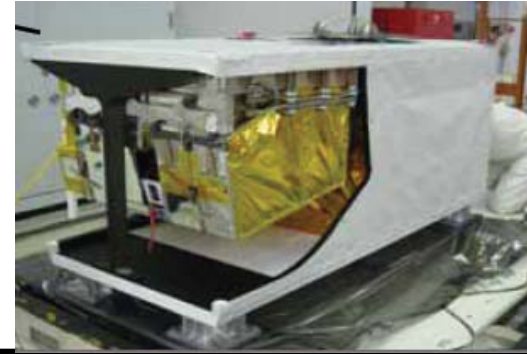
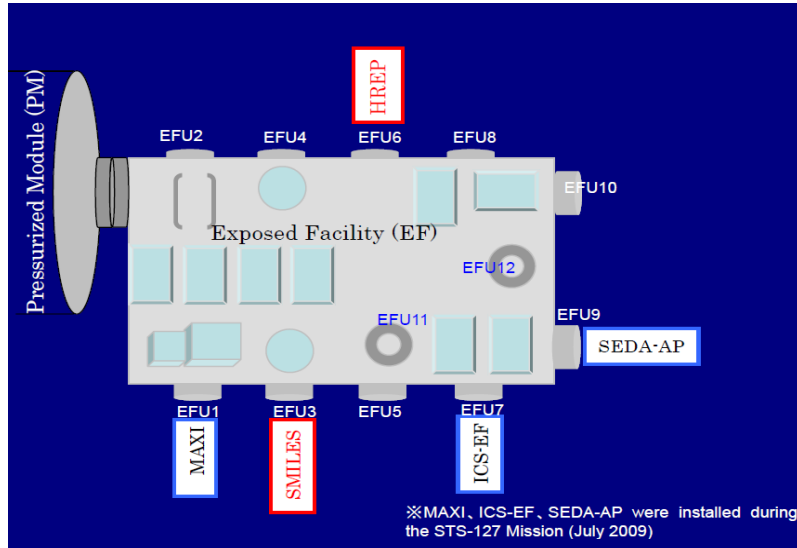


JEM RMS

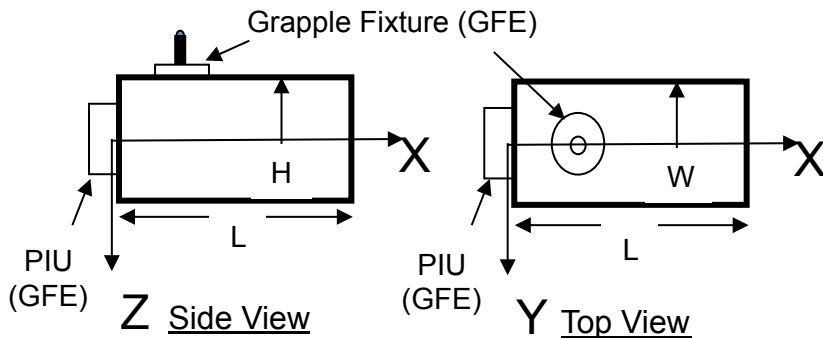
JEM External Facility



# JEM EF External Research Accommodations



NASA/DOD  
HREP payload

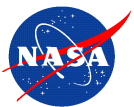


Axis	mm	ft	inch
W	800	2	7.50
H	1000	3	3.37
L	1850	6	0.83

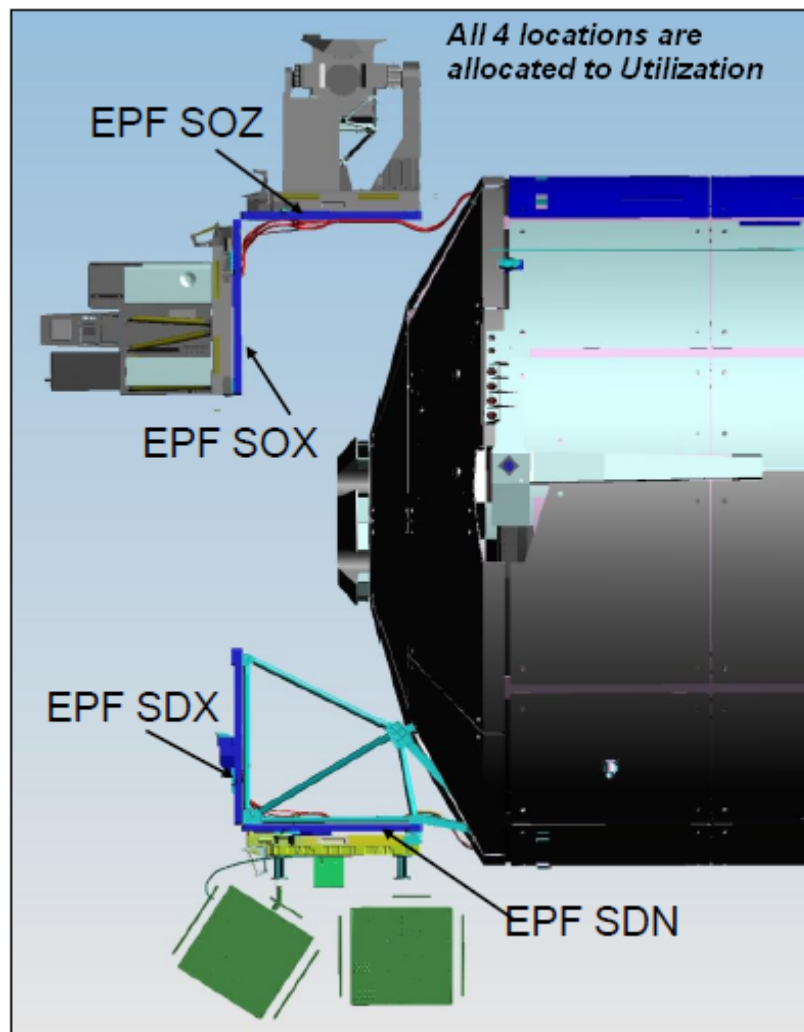
Mass capacity	550 kg (1,150 lb) at standard site 2,250 kg (5,550 lb) at large site
Volume	1.5 m <sup>3</sup>
Power	3-6 kW, 113 – 126 VDC
Thermal	3-6 kW cooling
Low-rate data	1 Mbps (MIL-STD-1553, two way)
Medium-rate data	1EEE-802.3(10BASE-T, two way) *
High-rate data	43 Mbps (shared, one way downlink)
Sites available to NASA	5 sites

- Ethernet bus is tested to 100BASE-T capacity.
- Upgrade to 100BASE-T is being worked by JAXA





# Columbus EF Overview



Location	Viewing	Payload Size	Power	Data
SOZ	Zenith	226 kg + CEPA	1.25 kW at 120 VDC 2.5 kW max	Ethernet, 1553
SOX	Ram			
SDX	Ram			
SDN	Nadir			



## Earth Venture 2 AO ISS Feasibility Assessment Process

---

(1) Contact the Technology Demonstration Office (TDO) (in Space Station Payloads Office, NASA JSC) to start a dialogue, and arrange an assessment telecon or meeting (George Nelson, [george.nelson-1@nasa.gov](mailto:george.nelson-1@nasa.gov), 281-244-8514).

*(2) Background information provided to an ISS assessment team, lead by TDO representative (Al Holt or Dave Hornyak). Information on proposed ISS payload (charts) should include:*

- Description of payload concepts and preliminary design approaches.
- Estimated launch/on-orbit mass, on-orbit volume/dimensions, power requirements, data downlink requirements, need for active cooling, and your assessment of where the payload could be located (ELC, JEM EF, and/or Columbus EF)
- Any mass or volume/dimensions which exceed standard operational payload envelopes for a particular site will require a waiver – small deviations can often be accommodated.
- We will assess your overall design approach and let you know where your payload exceeds standard envelopes, and options related to the exceedences.





## Earth Venture 2 ISS Feasibility Assessment Process

---

- (3) To complete the assessment a follow-up telecon may be needed, e-mail exchanges are to be expected.
- (4) Once the ISS assessment team has reviewed all potential ISS accommodations and interfaces, and has identified and briefly discussed these with proposer, the generation of a draft feasibility assessment letter can be initiated.
- (5) Draft of the ISS feasibility assessment letter will be sent to the proposer for any comments, near the end of an internal Space Station Payloads Office (SSPO) review of the letter
- (6) Letter (describing the results of the preliminary assessment) is approved and signed by the SSPO manager Rod Jones
  - Signed letter is then scanned in and sent by e-mail to the proposer with the original sent by regular mail.
  - More complete ISS assessment is conducted following payload's selection and funding commitment.

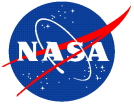


# Manifesting Process & Opportunities

---

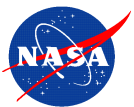
- When a payload is selected and/or funded, contact is made with the Space Station Payloads Office
- Technical Interchange Meetings (TIMs) or telecons are set up to provide a further assessment of the ISS's capability to support the payload and to provide answers to payload sponsors' questions.
- Around the same time, a request is made to add the payload to the Multi-Increment Payload Resupply and Outfitting Manifest (strategic plan for unpressurized or external payloads)
  - A particular, primary external payload site location is required at this point
  - Expected launch readiness date for the payload is used to locate the payload on the timeline





# EXAMPLE ONLY (Not Current) External Payload Manifesting (ELC)

FLIGHTS	Calendar Year		2012				2013				2014				2015			
	MONTH		MAR	APR	JUL	OCT	JAN	JUN	JUL	OCT	JAN	JUL	AUG	DEC	APR	JUL	DEC	
	Inc-Year		2012-1	2012-2		2013-1		2013-2		2014-1		2014-2		2015-1	2015-2		2016-1	
	Major Element(s)		Soyuz (Crew)	SpaceX CRS2	SpaceX CRS3	SpaceX CRS4	SpaceX CRS5	HTV	SpaceX CRS6	SpaceX CRS7	SpaceX CRS8	HTV	SpaceX CRS9	SpaceX CRS10	SpaceX CRS11	HTV	SpaceX CRS12	
	Flight		S0S	Sx2	Sx3	Sx4	Sx5	HTV4	Sx6	Sx7	Sx8	HTV5	Sx9	Sx10	Sx11	HTV6	Sx12	
Site Carrier Location Number Viewing			UNPRESSURIZED FACILITY LAUNCH / DISPOSAL PLANS AND ON-ORBIT TOPOLOGY															
ELC 1	P3 Lower	3	Outboard / Ram / Nadir										EuTEF-2 ↑ (NASA launch; ESA ops)	EuTEF-2	EuTEF-2	EuTEF-2	EuTEF-2 ↓	
		8	Inboard / Wake / Nadir				OPALS ↑ (NASA)	OPALS	OPALS	OPALS	OPALS	OPALS	OPALS	OPALS	OPALS	OPALS	OPALS ↓	
ELC 4	S3 Lower	2	Inboard / Wake / Nadir			DPP ↑ (NASA)	DPP	DPP	DPP	DPP		DPP ↓ STP-H4 (from E 3-5)	STP-H4	STP-H4	STP-H4 ↓	Tech, Earth, Exp & Space Sci Platform (ESA) ↑	Tech, Earth, Exp & Space Sci Platform	Tech, Earth, Exp & Space Sci Platform
		3	Inboard / Ram / Nadir	RRM <sup>3,8</sup>	RRM <sup>3,8</sup>	RRM <sup>3,8</sup>	RRM <sup>3,8</sup>	RRM <sup>3,8</sup>	RRM <sup>3,8</sup>	RRM <sup>3,8</sup>	RRM <sup>3,8</sup>	RRM <sup>3,8</sup> ↓ (TBR-6)	SAGE NVP (NASA) SAGE III/ Hexapod ↑ (NASA)	SAGE III/ Hexapod (w/NVP)	SAGE III/ Hexapod (w/NVP)	SAGE III/ Hexapod (w/NVP)	SAGE III/ Hexapod (w/NVP)	
ELC 2	S3 Upper	3	Inboard / Ram / Zenith	MISSE 8 <sup>2,3</sup>	MISSE 8 <sup>2,3</sup>	MISSE 8 <sup>2,3</sup>	MISSE 8 <sup>2,3</sup>	MISSE 8 <sup>2,3</sup> ↓ PRELSE II <sup>2</sup> ↑ (NASA)	PRELSE II <sup>2</sup>	PRELSE II <sup>2</sup>	PRELSE II <sup>2</sup>	PRELSE II <sup>2</sup>	PRELSE II <sup>2</sup>	PRELSE II <sup>2</sup>	PRELSE II <sup>2</sup>	PRELSE II <sup>2</sup>	PRELSE II <sup>2</sup>	
		7	Outboard / Ram / Zenith					TBD-E2-7 ↑ (NASA)	TBD-E2-7	TBD-E2-7	TBD-E2-7	TBD-E2-7	TBD-E2-7	TBD-E2-7	TBD-E2-7 ↓ TBD E2-7.2 ↑ (NASA)	TBD E2-7.2	TBD-E2-7.2	TBD E2-7.2
ELC 3	P3 Upper	3	Inboard / Ram / Zenith	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed <sup>3</sup>	SCAN Testbed-2 <sup>4</sup>
		5	Outboard / Wake / Zenith	STP-H3 <sup>3</sup>	STP-H3 <sup>3</sup>	STP-H3 <sup>3</sup> ↓		STP-H4 ↑ (NASA)	STP-H4	STP-H4	STP-H4 (to E4-2)	TBD E 3-5 ↑ (NASA)	TBD E 3-5	TBD E 3-5	TBD E 3-5	TBD E 3-5	TBD E 3-5	TBD E 3-5



# EXAMPLE ONLY (Not Current)

## External Payload Manifesting (JEM EF)

FLIGHTS	Calendar Year		2012				2013				2014				2015		
	MONTH		MAR	APR	JUL	OCT	JAN	JUN	JUL	OCT	JAN	JUL	AUG	DEC	APR	JUL	DEC
	Inc-Year		2012-1	2012-2		2013-1		2013-2		2014-1		2014-2		2015-1	2015-2		2016-1
	Major Element(s)		Soyuz (Crew)	SpaceX CRS2	SpaceX CRS3	SpaceX CRS4	SpaceX CRS5	HTV	SpaceX CRS6	SpaceX CRS7	SpaceX CRS8	HTV	SpaceX CRS9	SpaceX CRS10	SpaceX CRS11	HTV	SpaceX CRS12
	Flight		30S	Sx2	Sx3	Sx4	Sx5	HTV4	Sx6	Sx7	Sx8	HTV5	Sx9	Sx10	Sx11	HTV6	Sx12
Site Carrier Location Number Viewing			UNPRESSURIZED FACILITY LAUNCH / DISPOSAL PLANS AND ON-ORBIT TOPOLOGY														
JEM-EF	1	Ram	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>	MAXi <sup>3</sup>
	3	Ram	SMILES <sup>3</sup>	SMILES <sup>3</sup>	SMILES <sup>3</sup>	SMILES <sup>3</sup>	SMILES <sup>3</sup>	SMILES <sup>3</sup>	SMILES <sup>3</sup>	SMILES <sup>3</sup>	SMILES <sup>3</sup>	SMILES <sup>3</sup>	SMILES <sup>3</sup> (TBR-2) ↓				
	5	Ram															
	7	Ram															
	9 <sup>5</sup>	Ram	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup> (to J-11)	CALET ↑ (TBR-2) (GOJ)	CALET	CALET	CALET	CALET	CALET
	2	Wake										TBD-J-2 ↑ (TBR-2) (NASA)	TBD-J-2	TBD-J-2	TBD-J-2	TBD-J-2	TBD-J-2
	4	Wake							TBD-J-4 <sup>7</sup> ↑ (TBR-1) (NASA)	TBD-J-4 <sup>7</sup>	TBD-J-4 <sup>7</sup>	TBD-J-4 <sup>7</sup>	TBD-J-4 <sup>7</sup>	TBD-J-4 <sup>7</sup>	TBD-J-4 <sup>7</sup>	TBD-J-4 <sup>7</sup>	TBD-J-4 <sup>7</sup>
	6	Wake	HREP <sup>3</sup>	HREP <sup>3</sup>	HREP <sup>3</sup>	HREP <sup>3</sup>	HREP <sup>3</sup>	HREP <sup>3</sup>	HREP <sup>3</sup>								
	8	Wake	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>	MCE <sup>3</sup>
	10	Wake															
	11	Zenith											SEDA-AP <sup>3</sup> (from J-9)	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup>	SEDA-AP <sup>3</sup>
12 <sup>6</sup>	Zenith																
S3 Upper Inboard			Zenith	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>	AMS <sup>3</sup>





```
graph TD; Top[Payload-specific Resource Definition and Two-pagers (RPO) | ISS Payloads Office Feasibility Assessments (Integration Organizations) | Payload-prioritization (ISS Program Scientist)] -- "~ Increment minus 19 months" --> RPWG[Research Planning Working Group (RPWG)]; Left[Flight & Increment-specific Utilization Allocations (ISS Program Office) (Up/downmass, Crewtime, Power, etc)] --> RPWG; Right[Launch Schedules (Shuttle, Russians, ESA, JAXA, ISS Program Office)] --> RPWG; RPWG --> IRP[Increment-specific Research Plan]; IRP --> PCB[ISS Payloads Control Board]; PCB --> PTP[Payload Tactical Plan (PTP)]; PTP -- "~ Increment minus 16 months" --> End[ ];
```

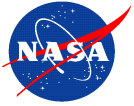
The diagram illustrates the process of the Research Planning Working Group (RPWG) for the ISS. It begins with three input boxes at the top: "Payload-specific Resource Definition and Two-pagers (RPO)", "ISS Payloads Office Feasibility Assessments (Integration Organizations)", and "Payload-prioritization (ISS Program Scientist)". These inputs feed into the central "Research Planning Working Group (RPWG)" box, which is labeled "~ Increment minus 19 months". The RPWG also receives input from "Flight & Increment-specific Utilization Allocations (ISS Program Office)" (including Up/downmass, Crewtime, Power, etc.) and "Launch Schedules (Shuttle, Russians, ESA, JAXA, ISS Program Office)". The RPWG outputs an "Increment-specific Research Plan", which then feeds into the "ISS Payloads Control Board". The Control Board outputs the "Payload Tactical Plan (PTP)", which is labeled "~ Increment minus 16 months".



# Payload Integration Process

---

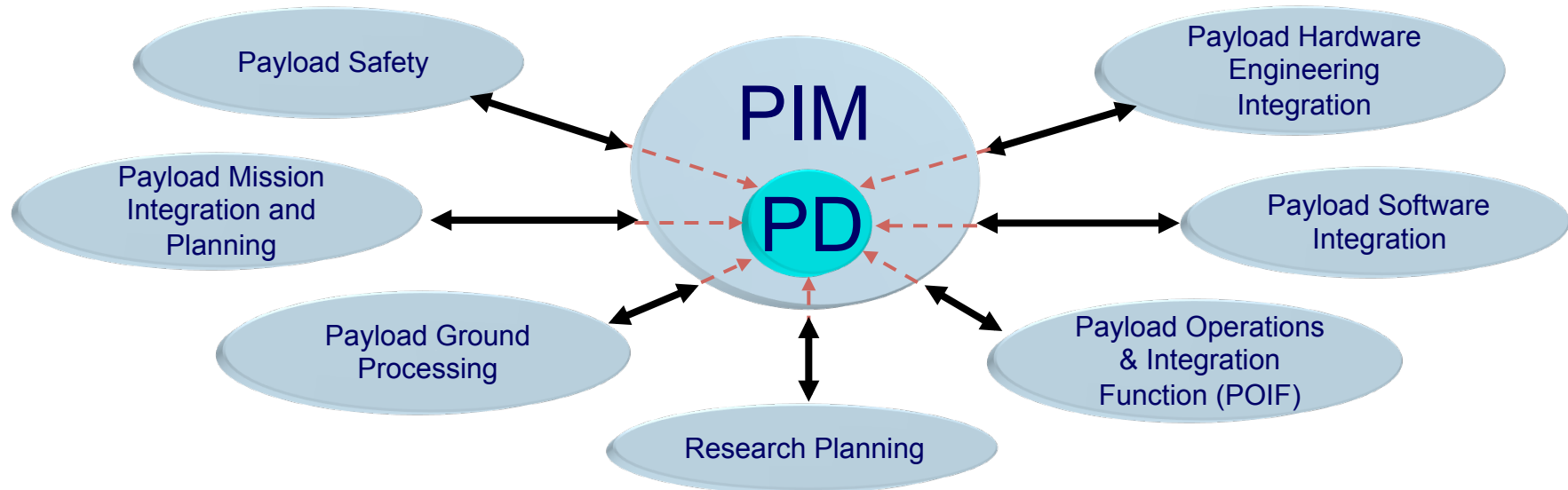
- Often before the start of the Research Planning process (especially for external payloads), a Strategic Payload Integration Manager starts working with the payload development team, and later a permanent Payload Integration Manager is assigned.
- Once a kick-off/transition meeting is held, the Payload Integration Manager (PIM) from then on leads the Technical Interchange Meetings, and acts as the central point of contact for interaction with other offices in the Space Station Program Office and ISS analytical services.
- Technology Demonstration Office (and other NASA ISS payload sponsoring organizations) continue to provide support to the payload developer, as needed through the integration and operations' phases.



# Payload Integration Manager

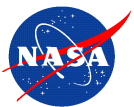
## ◆ NASA Payload Integration Manager (PIM)

- Functions as the Payload Developer's primary interface to the ISS Program
- Serves as payload advocate while protecting ISS Program Requirements

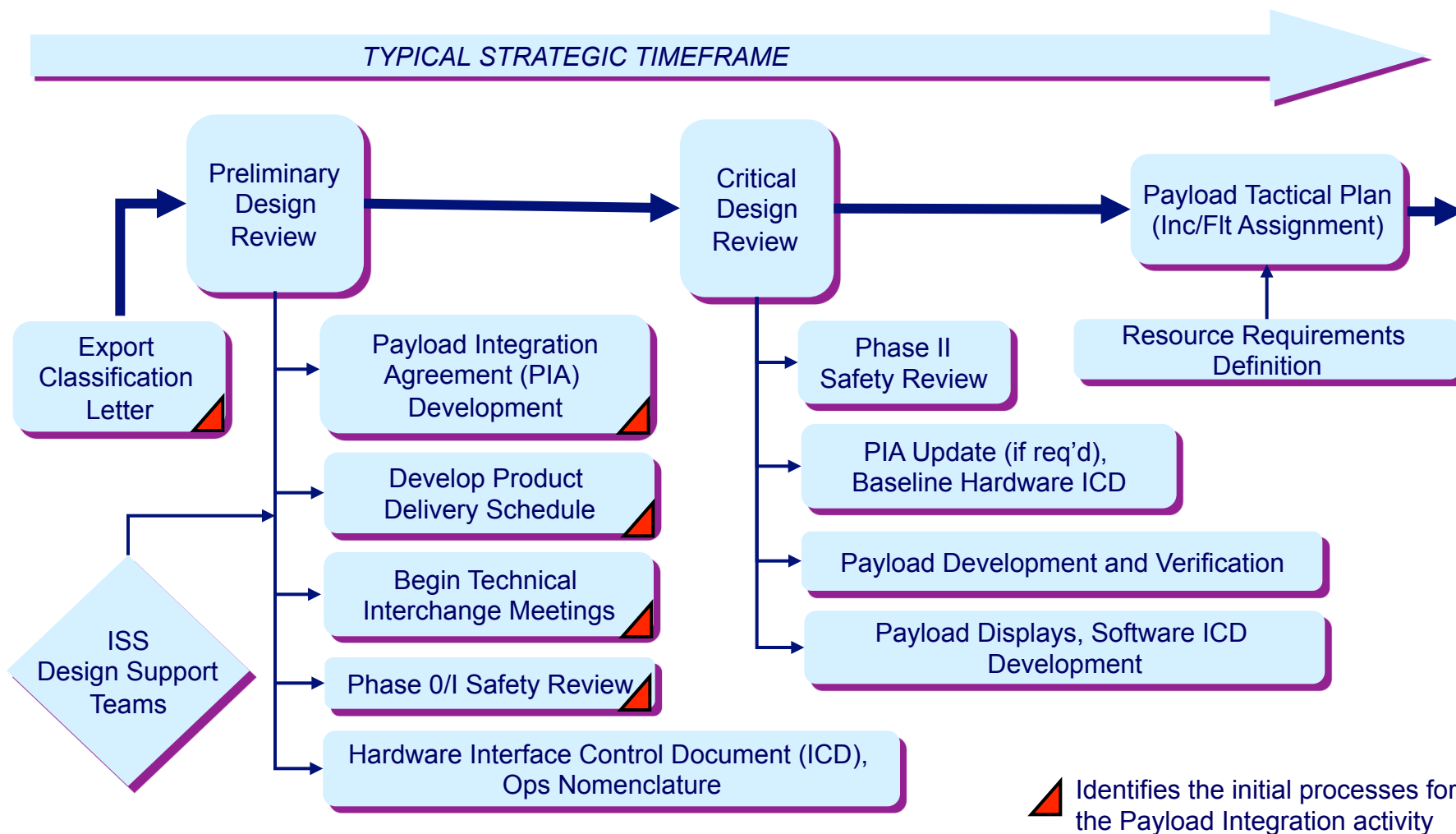


- Ensures payload requirements are accurately defined and documented
- Facilitates payload integration product development, delivery schedules, and communications with the ISS Program



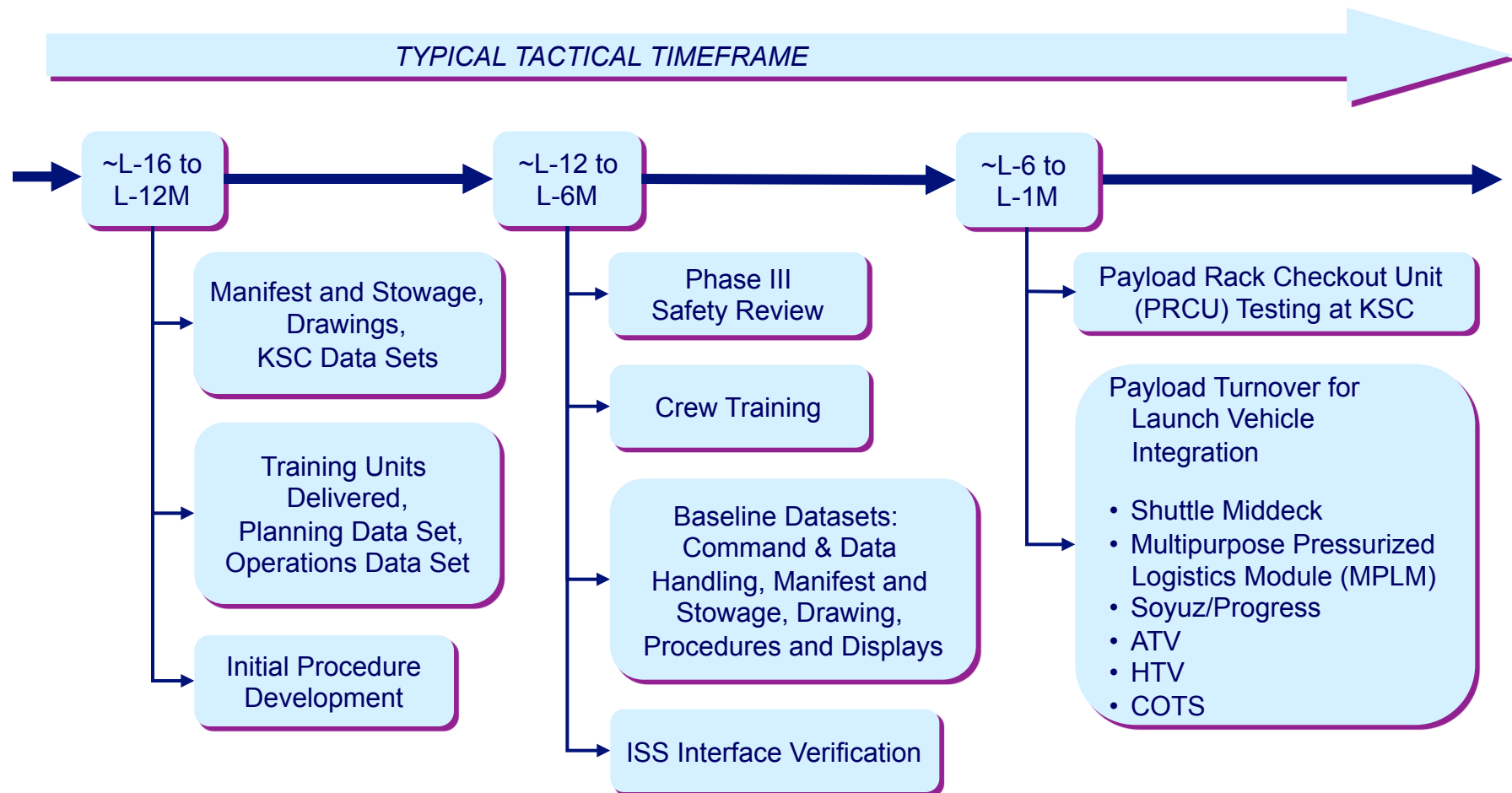


# Strategic Timeframe Overview





# Tactical Timeframe Overview



Note: EXPRESS Sub-rack payloads will have a compressed integration cycle





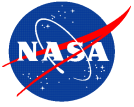




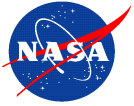
For technical/process questions associated with  
International Space Station Payloads contact:

Dr. George Nelson  
Earth Venture 2 ISS Payload POC  
Space Station Payload Office  
Mail Stop OZ  
NASA Johnson Space Center  
Houston, TX 77058  
Tel: 281-244-8514  
Email: [george.nelson-1@nasa.gov](mailto:george.nelson-1@nasa.gov)

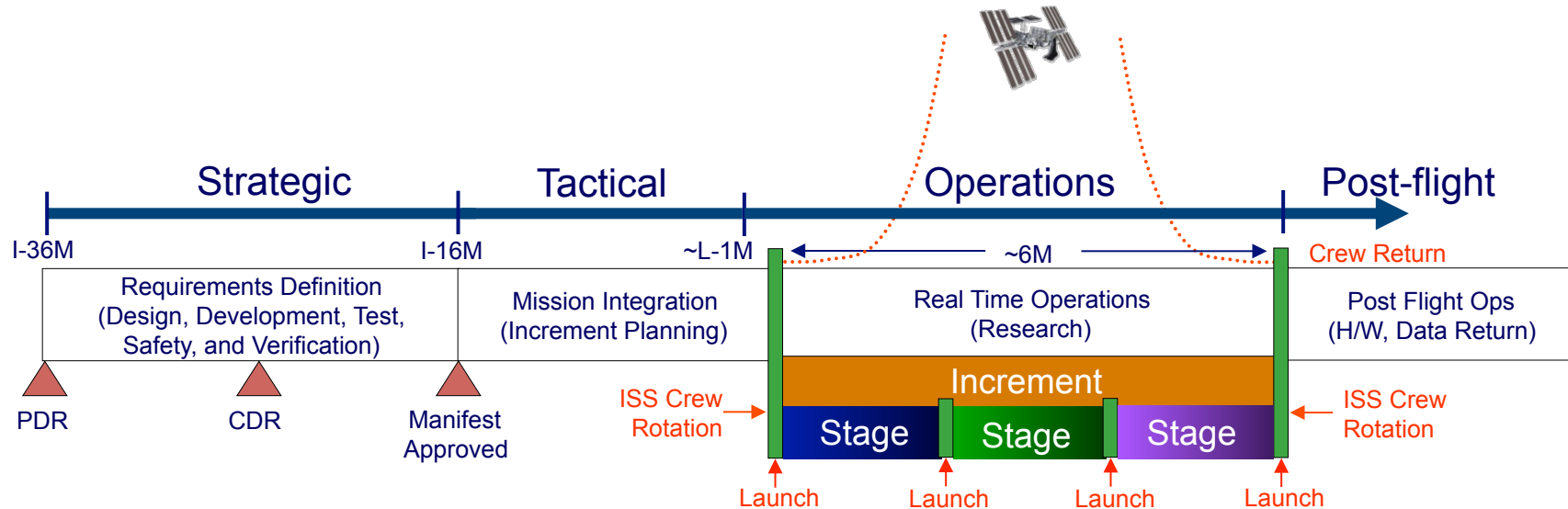
**Customer Service Helpline** :The International Space Station Payloads Office has both a phone and an email customer service helpline that Payload Developers and others interested in doing research can contact to get assistance. The phone is staffed during regular business hours, or messages may be issued after hours, and a representative will return the call on the next business day. Phone: 281-244-6187, email: [jsc-iss-payloads-helpline@mail.nasa.gov](mailto:jsc-iss-payloads-helpline@mail.nasa.gov).”



# Back-Up Charts



# ISS Standard Payload Integration Process



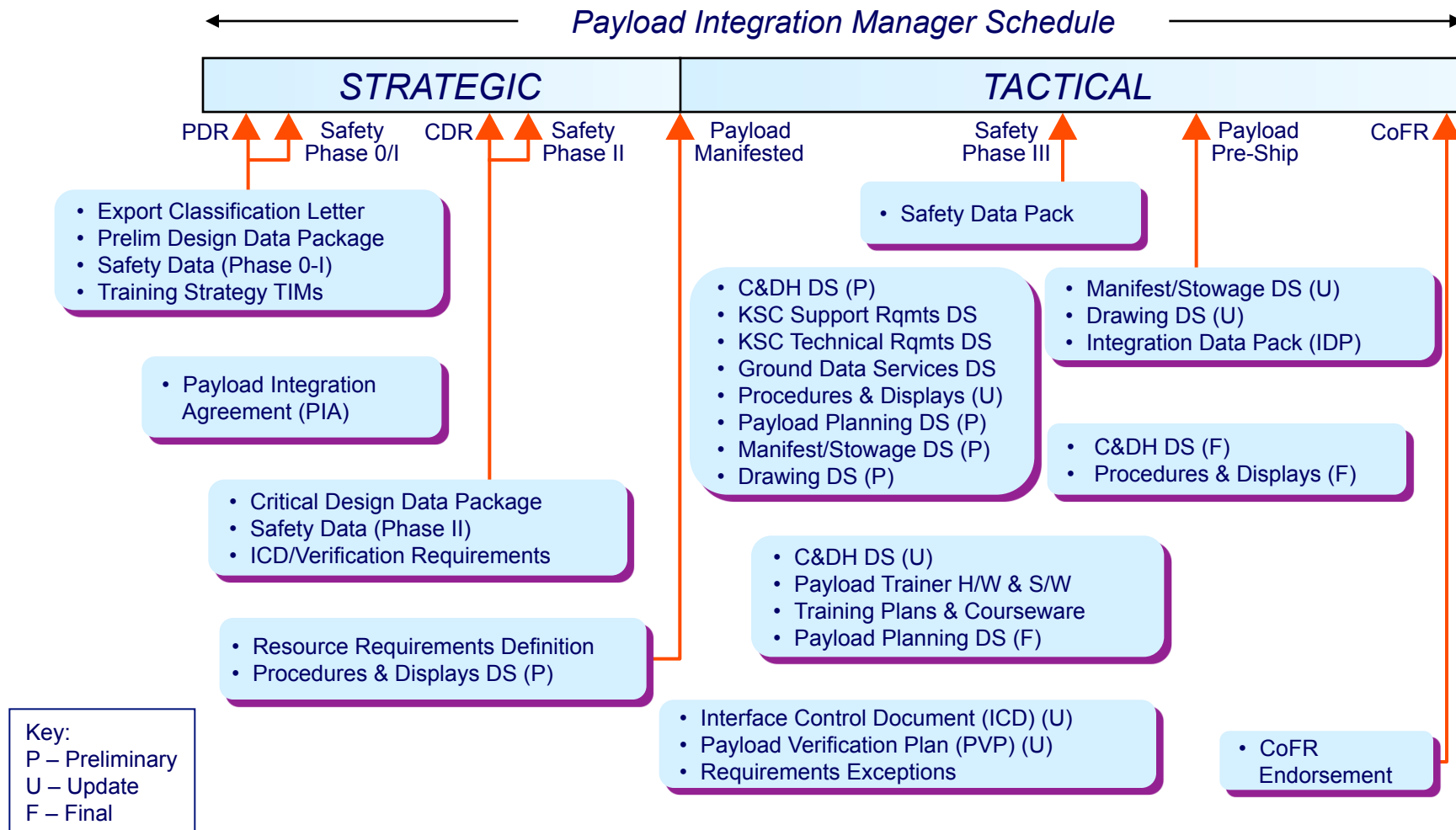
NASA PIMs provide integration leadership during all phases of the payload's life cycle

- **Strategic** – ISS integration requirements, products, and schedule development to ensure that an ISS compatible payload is built; support manifest process (payload data collection and feasibility assessments)
- **Tactical** – represent PD interests to Increment and Flight-specific teams to ensure that integration and operations requirements are addressed; provide oversight for payload CoFR and verification submittals
- **Operations** – assist with operations issue resolution between the PD and the Increment Payload Manager; maintains payload insight; and coordinates payload resupply or return requirements; assure payload CoFR and verification submittals during payload lifetime on-orbit
- **Post-flight** – coordinate vehicle deintegration requirements; return of payload material from the landing site to the PD; and Lessons Learned submittals





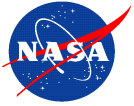
# Integration Products



# Dexterous End Effector



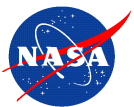
*SSRMS attachment which the ground team or on-orbit crew can use robotically to install, remove and replace payloads and failed components*



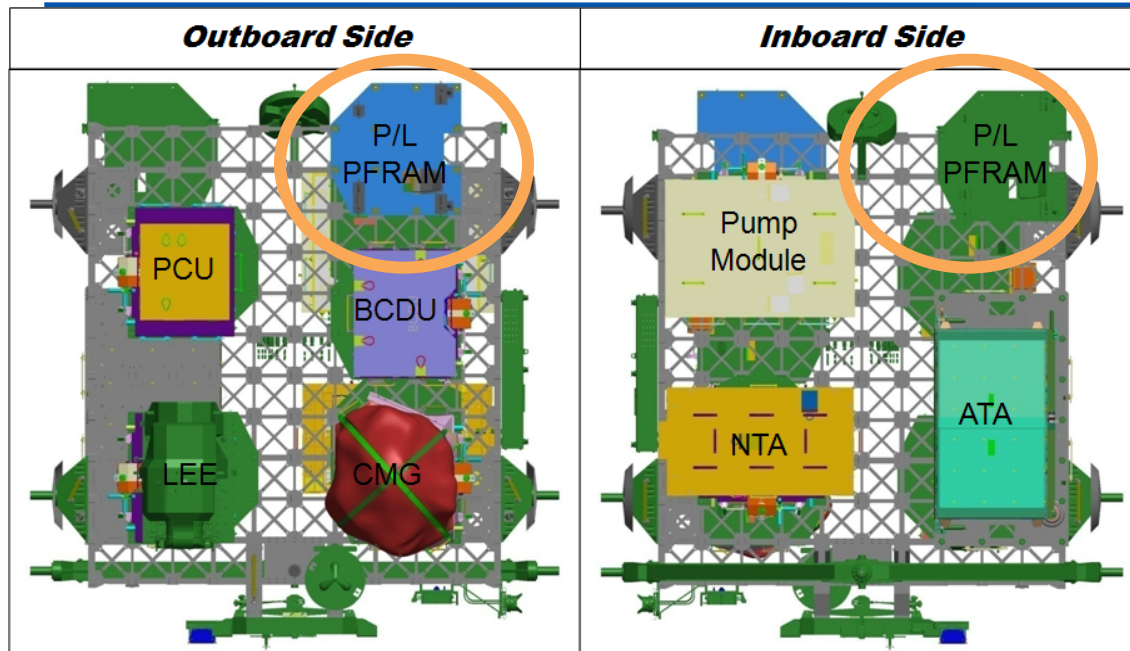
# JEM RMS Payload Support





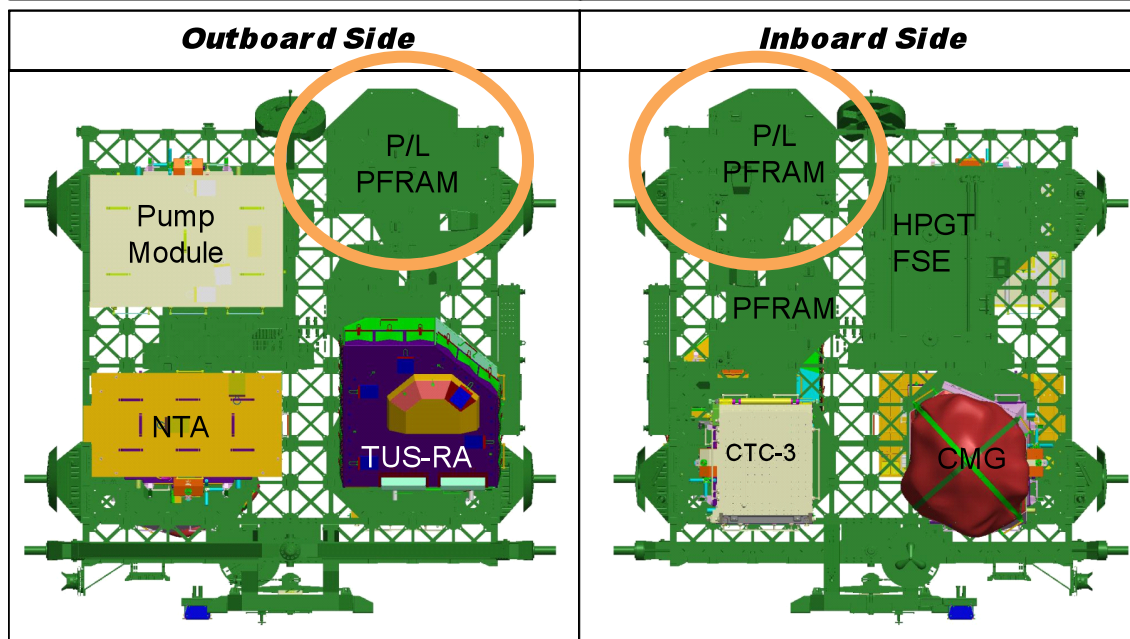


# Express Logistics Carriers Overview

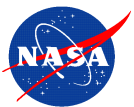


*Payload Locations Circled*

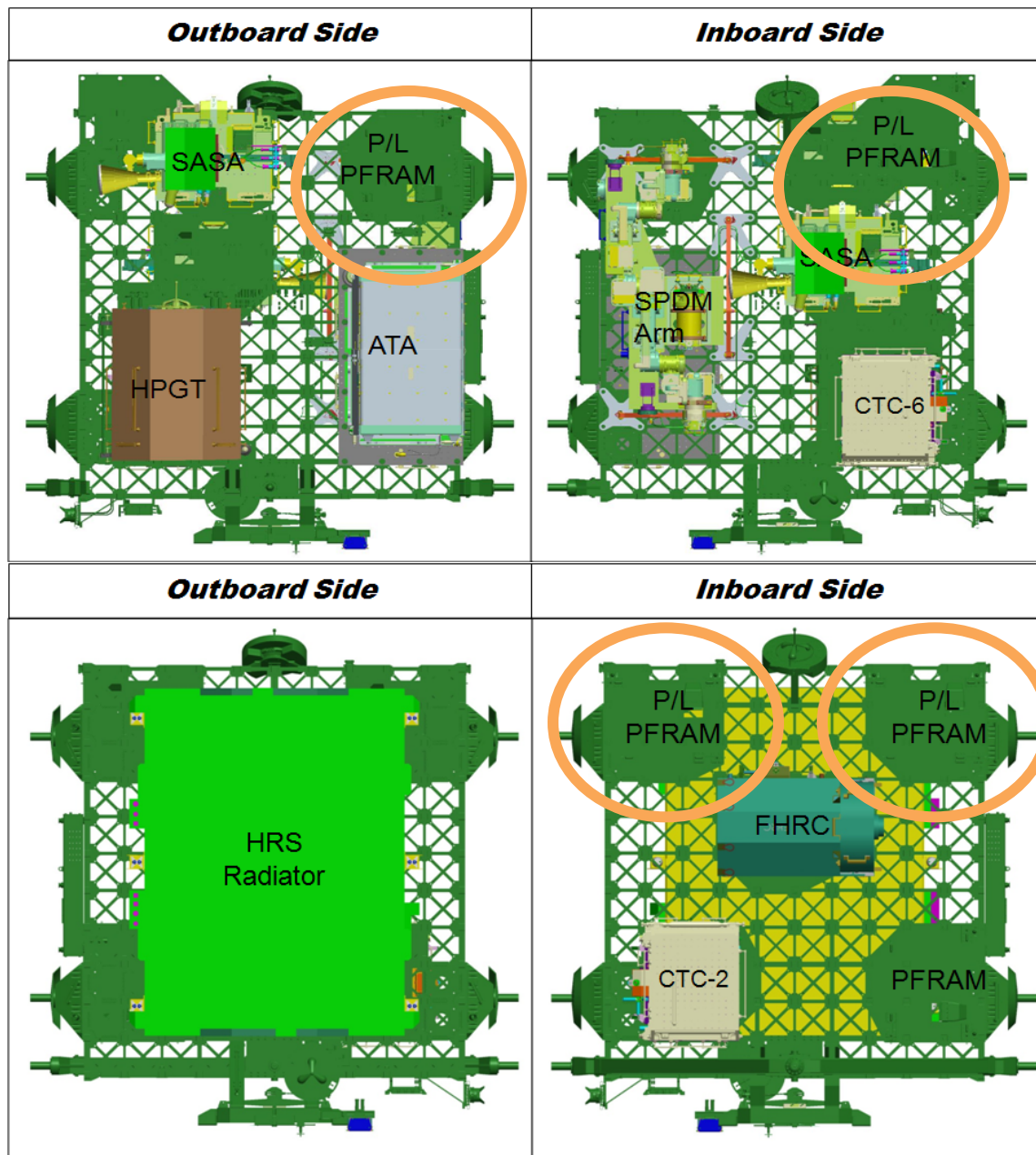
ELC-1  
Port lower  
2 Nadir payload sites



ELC-2  
Starboard upper  
2 Zenith payload sites



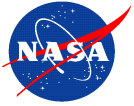
# Express Logistics Carriers Overview



*Payload Locations Circled*

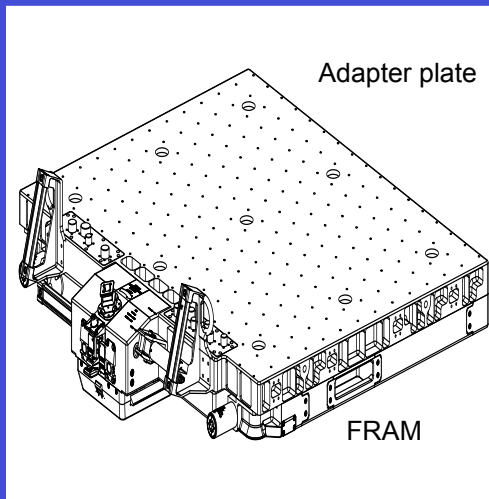
ELC-3  
Port upper  
2 Zenith payload sites

ELC-4  
Starboard lower  
2 Nadir payload sites

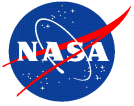


# Express Pallet Adapter (ExPA) Assembly (GFE)

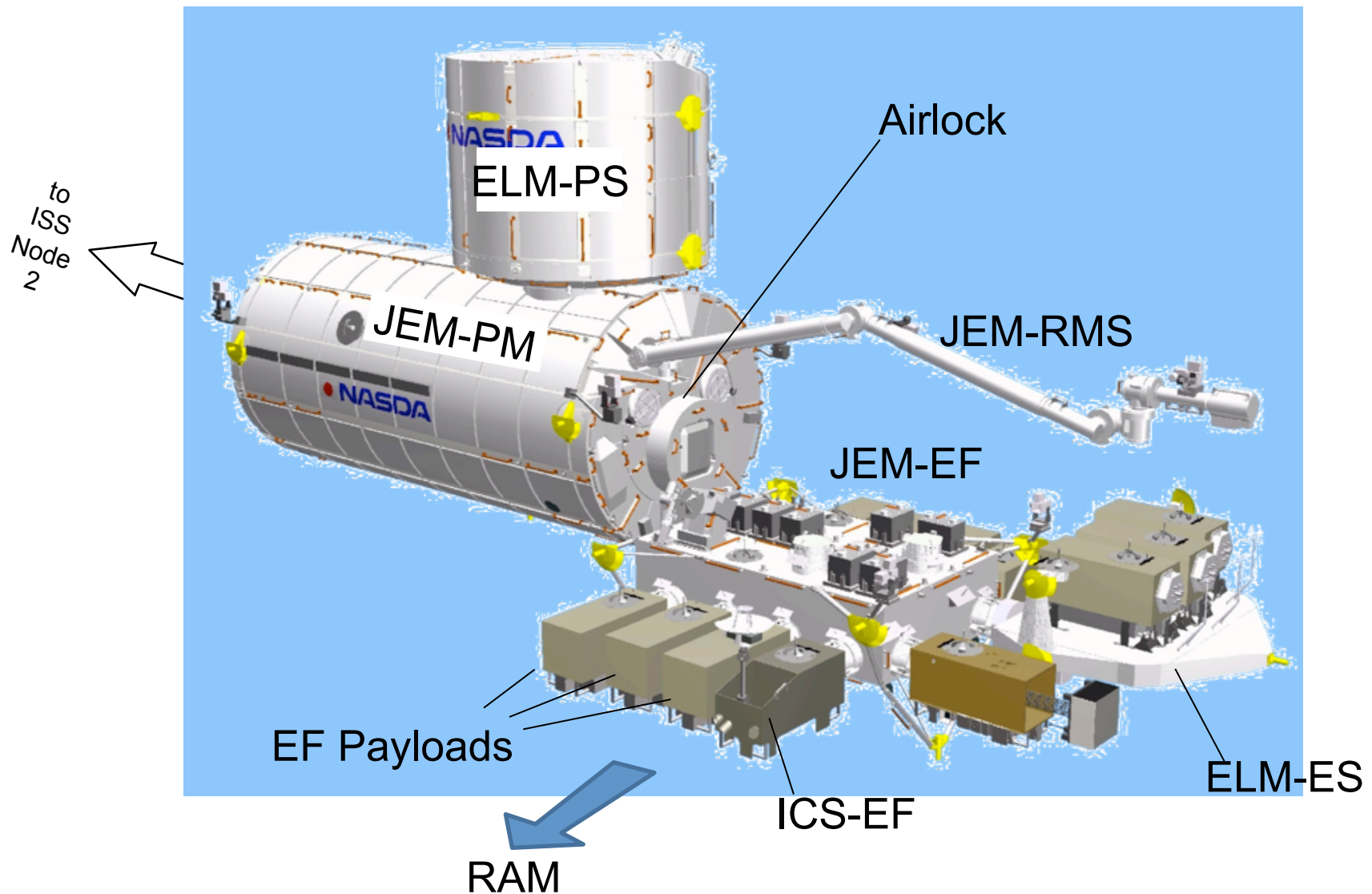
## Express Pallet Adapter (ExPA) Assembly



ExPA overall Mass	255 lb
ExPA overall dimension	46.05" x 47" x 13.06" (H)
ExPA payload carrying capability	34" x 46" x 49" (H) and 500 lb"
Payload electrical interface	Power(120VDC & 28VDC): Four NATC connectors Data (1553, Ethernet): Six NATC connectors
Payload thermal interface	Active heating, passive cooling
Payload structural interface	2.756" X 2.756" Grid with 250-28 UNF Locking Inserts and 1.625" diameter Shear Boss Provisions
EVA compatibility	EVA handrail provisions
EVR compatibility	All EVR interfaces on ExPA



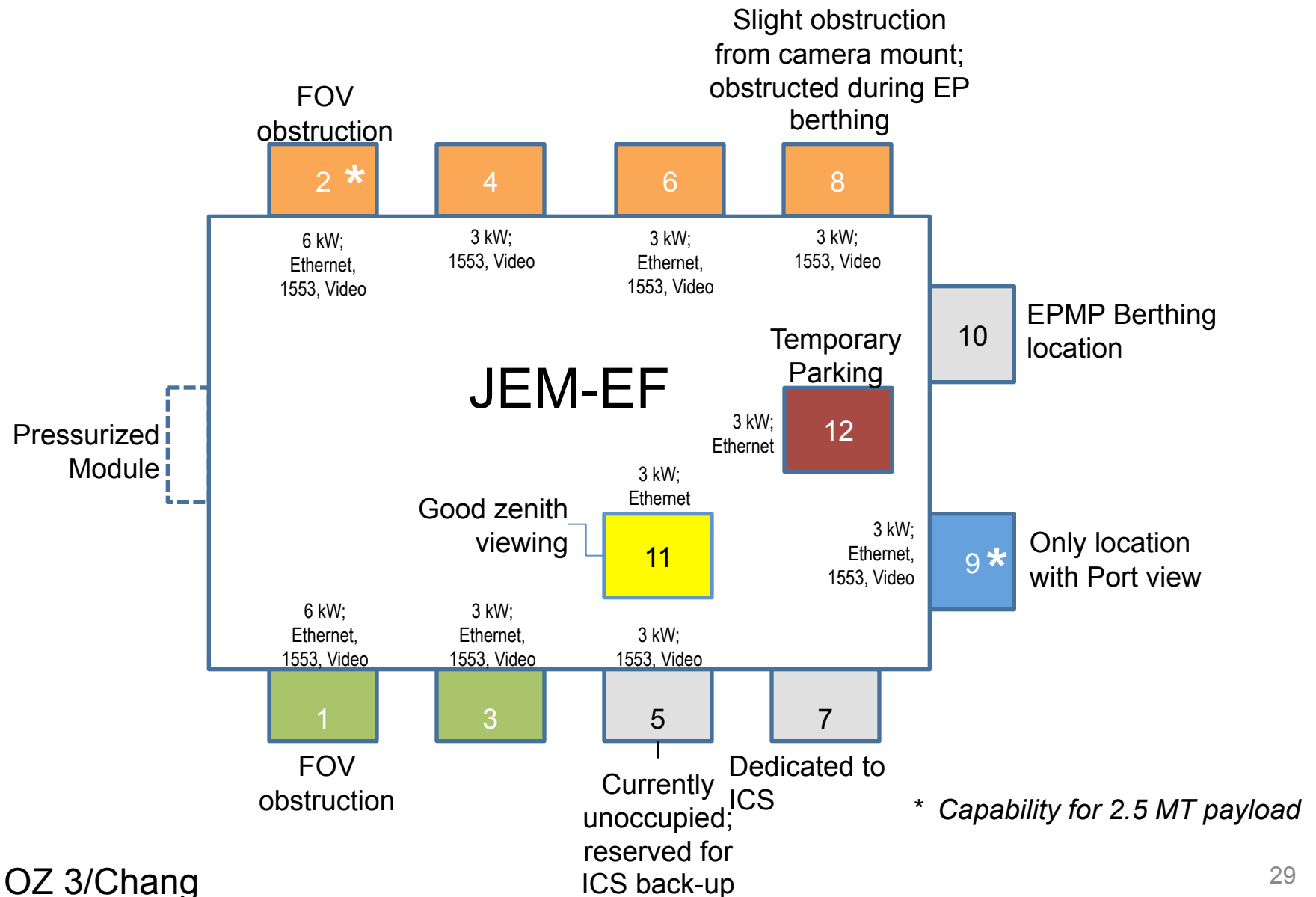
## Japanese Experiment Module Exposed Facility (JEM EF) Overview

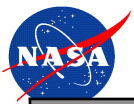






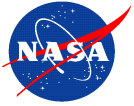
# JEM EF EFU Location Overview





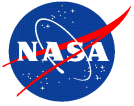
# JEM-EF Detailed Accommodations by Site

Location	Viewing	Payload Size	Description / Notes	Power	Data
1	Ram, Nadir, Zenith	500 kg	Ram field of View (FOV) obstruction by JEM module	6 kW	Ethernet, 1553, Video
3	Ram, Nadir, Zenith	500 kg	Clear view	3 kW	Ethernet, 1553, Video
5	Ram, Nadir, Zenith	500 kg	ICS System back-up site (negotiable?)	3 kW	Ethernet, 1553, Video
7	Ram, Nadir, Zenith	500 kg	ICS-dedicated	-	-
9	Port, Zenith, Nadir	2.5 MT	Best volumetrically for large payloads (up to 2.5 MT), but not necessarily the best viewing	3 kW	Ethernet, 1553, Video
2	Wake, Nadir, Zenith	2.5 MT	Can hold large payloads, but has an FOV obstruction by JEM module	6 kW	Ethernet, 1553, Video
4	Wake, Nadir, Zenith	500 kg	Clear view	3 kW	1553, Video
6	Wake, Nadir, Zenith	500 kg	Clear view	3 kW	Ethernet, 1553, Video
8	Wake, Nadir, Zenith	500 kg	Obstruction during EP berthing, slight obstruction from camera mount	3 kW	1553, Video
10	Wake, Nadir, Zenith	500 kg	EPMP berthing site	-	-
11	Zenith only	500 kg	Good Zenith viewing	3 kW	Ethernet
12	Zenith only	500 kg	Temporary stowage location	3 kW	Ethernet



# Columbus EF

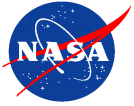




## Payload Allowable Up-Mass & Volume Summary Table

Attach Payload Location	Allowable Payload Weight (including Flight Support Equipment)	Accommodation Weight (including adapter plate)	Total Weight	Payload Volume (W x H x L)
HTV Exposed Pallet (JEM EF Payload)	979 Lb (445 Kg)	121 Lb (55 Kg)	1100 Lb (500 Kg)	31.5" x 39.4" x 72.8" (800mm x 1000mm x 1850 mm)
HTV Exposed Pallet (ExPA, CEPA Payload)	See ExPA & CEPA payload specification for ELC & CEF	See ExPA & CEPA payload specification for ELC & CEF	*See ExPA & CEPA payload specification for ELC & CEF	*See ExPA & CEPA payload specification for ELC & CEF
ELC (ExPA)	490 Lb (222 Kg)	250 Lb (114 Kg)	740 Lb (336 Kg)	34" x 49" X 46" (863mm x 1244mm x 1168 mm)
Columbus (CEPA)	388 Lb (176Kg)	250 Lb (114 Kg)	638 Lb (290 Kg)	34" x 49" X 46" (863mm x 1244mm x 1168 mm)
JEM-EF	979 Lb (445 Kg)	121 Lb (55 Kg)	1100 Lb (500 Kg)	31.5" x 39.4" x 72.8" (800mm x 1000mm x 1850 mm)

\* Location constraint applies in HTV Exposed Pallet



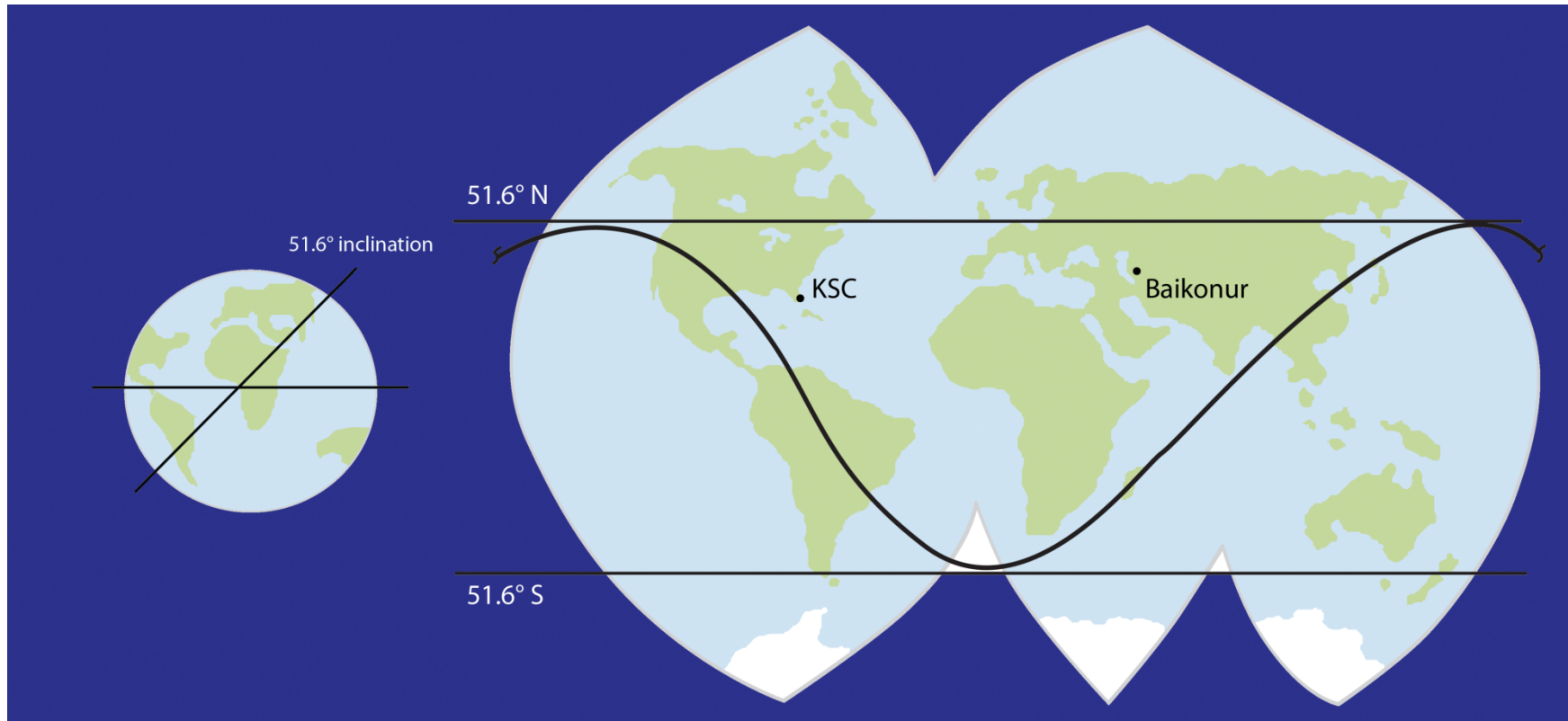
# Upgrades In Work

<b>Enhanced Processor and Integrated Communications (EPIC) Project</b>	Phase A will upgrade the three Command and Control (C&C) MDMs and the two Guidance, Navigation, & Control (GN&C) MDMs.
	Phase B will upgrade the two Payload MDMs, and add Ethernet support for the C&C and Payload MDMs.
<b>Air to Ground High Rate Communications System (HRCS) Project</b>	Increase data rates internally and on the RF link 300 Mbps downlink, 7/25 Mbps uplink
	Combine audio and video on orbit
	Provide two way, high quality audio
	Open the door to internet protocol communications
	Open the forward link to multiple users
<b>On Orbit External Wireless High Rate</b>	Allow for the capability of transmitting & recording HDTV
	100 Mbps 2-way Ethernet capability
	1 Mbps 1553 capability
	Up to 4 antennas attached to EVA handrails on US Lab





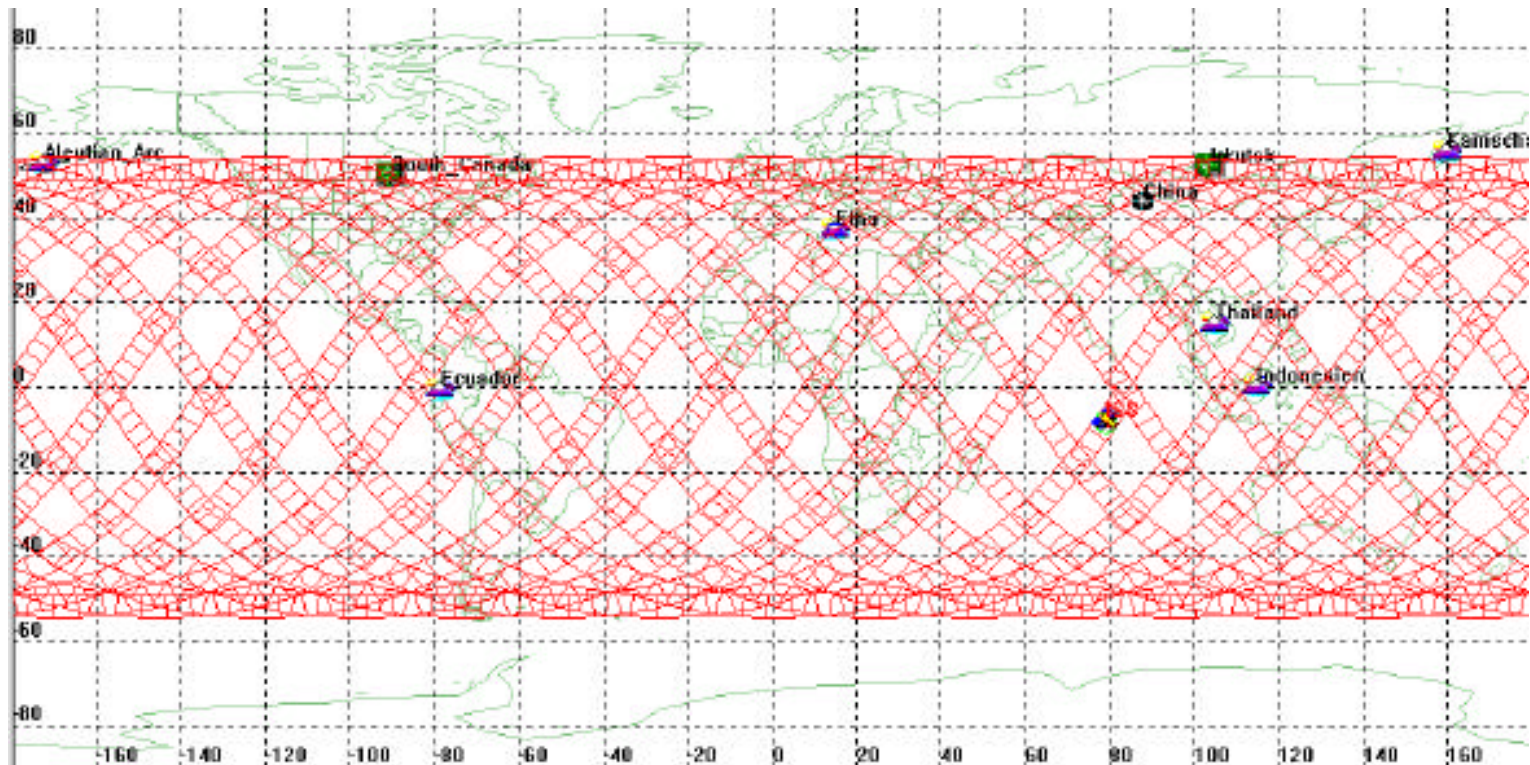
# ISS as a Platform for Earth Science



All geographic locations between 51.6 North and South latitude  
can be observed NADIR pointing  
Provides coverage of 85% of the Earth's surface and 95% of the world's  
populated landmass every 1-3 days

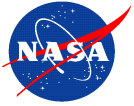


# ISS as a Platform for Earth Science



*ISS coverage in 24 hrs for a 70°-swath optical payload. (Courtesy of ESA)*

Processing lighting (changes with subsequent passes)  
Well-suited for test bed concepts with hardware change out  
and upgrades



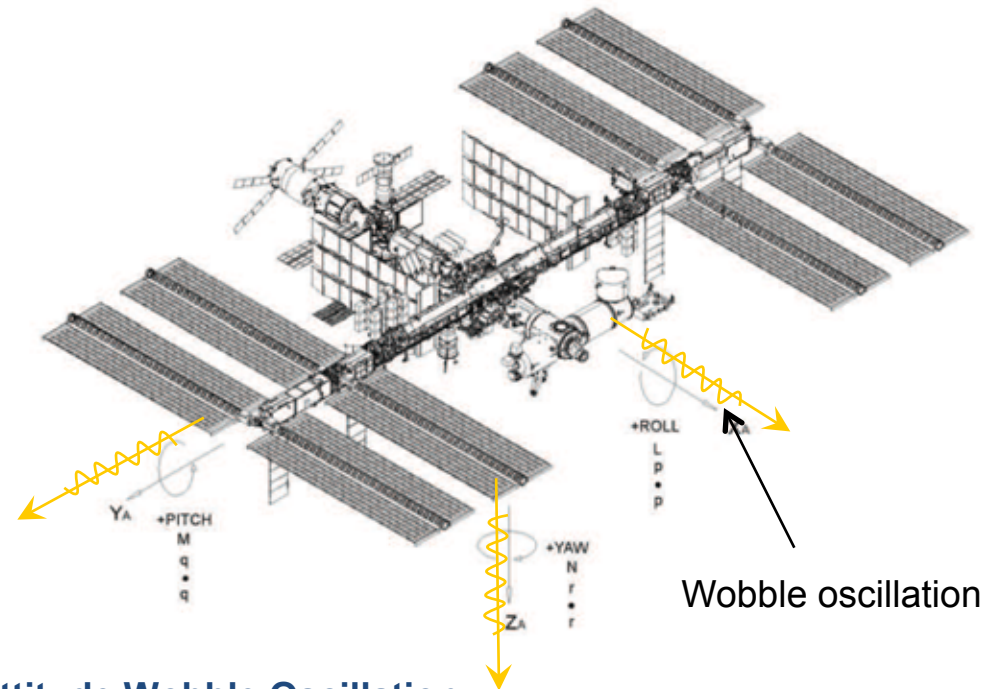
# ISS Attitude Torque Equilibrium Attitude (TEA) & Wobble Oscillation Description

For Stage configurations (i.e.; no Orbiter or Orbiter sized vehicle docked on the ISS) in the foreseeable future, the predicted TEA ranges are:

Roll: -1.0 ~ +3.0 deg

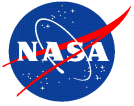
Pitch: -7.0 ~ +2.0 deg

Yaw: -15 ~ +15 deg.



## Momentum Manager Controller Peak to Peak Attitude Wobble Oscillation

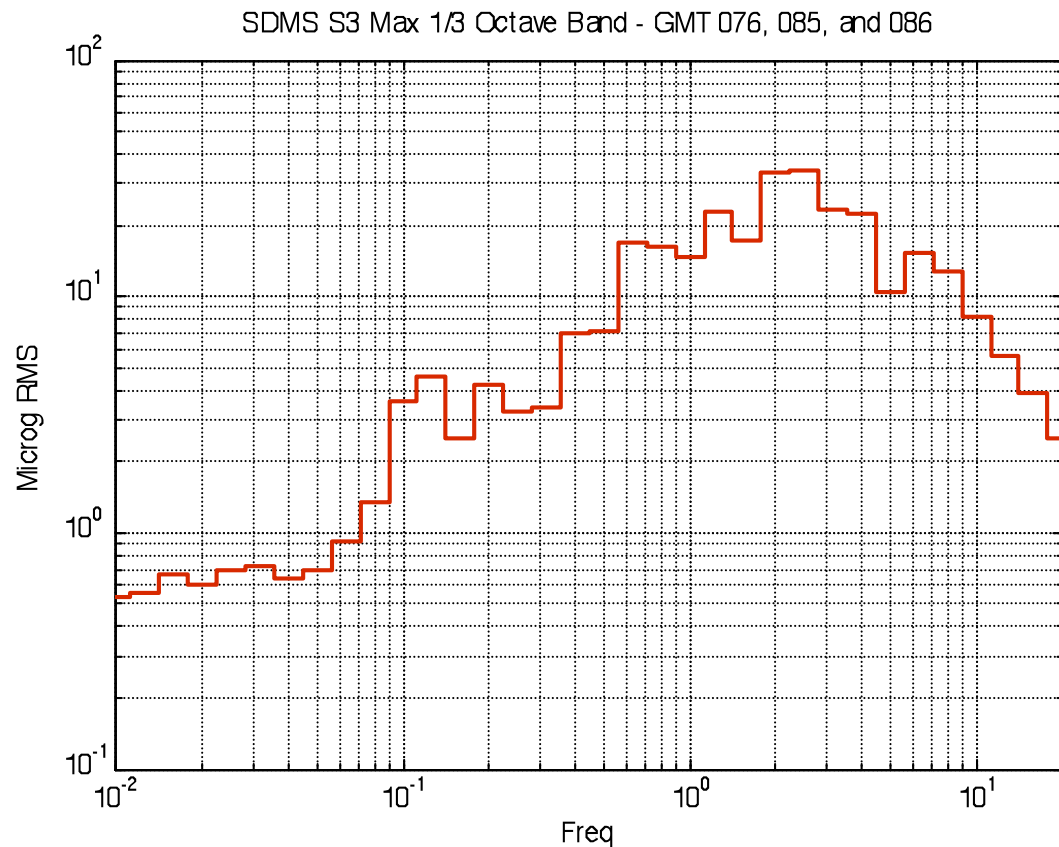
Performance Descriptions	Peak to Peak Attitude Oscillations Per Orbit			Peak Attitude Variation from Steady-State Orbit-Average Attitude		
	Roll (X) (deg)	Pitch (Y) (deg)	Yaw (Z) (deg)	Roll (X) (deg)	Pitch (Y) (deg)	Yaw (Z) (deg)
Non-Micro-Gravity (Assembly Stages) Non-Propulsive (Momentum Manager) Attitude Control Performance Requirement	10.0	10.0	10.0	+/- 5	+/- 5	+/- 5
Micro-Gravity (Assembly Complete) Non-Propulsive (Momentum Manager) Attitude Control Performance Requirement	7.0	7.0	7.0	+/- 3.5	+/- 3.5	+/- 3.5
Typical Steady-State Performance of <b>Minimum</b> CMG momentum oscillation Momentum Manager Controller	1.6	1.6	2.0	+/- 0.8	+/- 0.8	+/- 1
Typical Steady-State Performance of <b>Minimum</b> Attitude oscillation Momentum Manager Controller	1.6	0.4	0.2	+/- 0.8	+/- 0.2	+/- 0.1
Typical Steady-State Performance of <b>Minimum</b> CMG momentum & Attitude oscillation <b>Blended</b> Momentum Manager Controller	1.6	0.7	1.2	+/- 0.8	+/- 0.35	+/- 0.6



# ISS Quiescent Mode Truss Vibratory Environment For External Payload Pointing Instrument

Data measured on ISS S3 truss

- ISS quiescent mode = No thruster firings, dockings, EVA, or robotics operations
- Typical response, not worst case
- Maximum per octave band
  - SDMS S3B1N on-orbit accelerometer data.
  - Snapshot of 3 10-minute data takes
  - All data taken on March 16, 26, and 27, Stbd SARJ Rotating, exercise, 3 crew.



*ULF-4 analysis concluded peak ELC rotations on the order of 0.03 degrees (quiescent mode)*





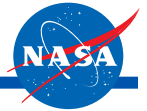
## ISS Contamination Environment Description For Truss Attached Payload

- The International Space Station provides an exceptionally clean environment to external payloads and science assets
- External contamination control requirements limit contaminant deposition to 130Å/year on external payloads and ISS sensitive surfaces
  - Specified levels are lower than any previous space station (Mir, Skylab, Salyut) by several orders of magnitude
- Measurements of contaminant deposition on ISS returned hardware have demonstrated that requirements are met at ISS payload sites

Experiment	Side	Requirement (130Å/year)	Measured
MISSE 2	ram	520 Å (4 years)	50 Å
	wake	520 Å (4 years)	500 Å
Node 1 nadir window cover	nadir	390 Å (3 years)	50 Å



# Window Observational Research Facility (WORF)

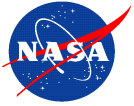


US Laboratory Window  
50-cm diameter  
Telescope-quality optical glass  
NADIR view



WORF Rack

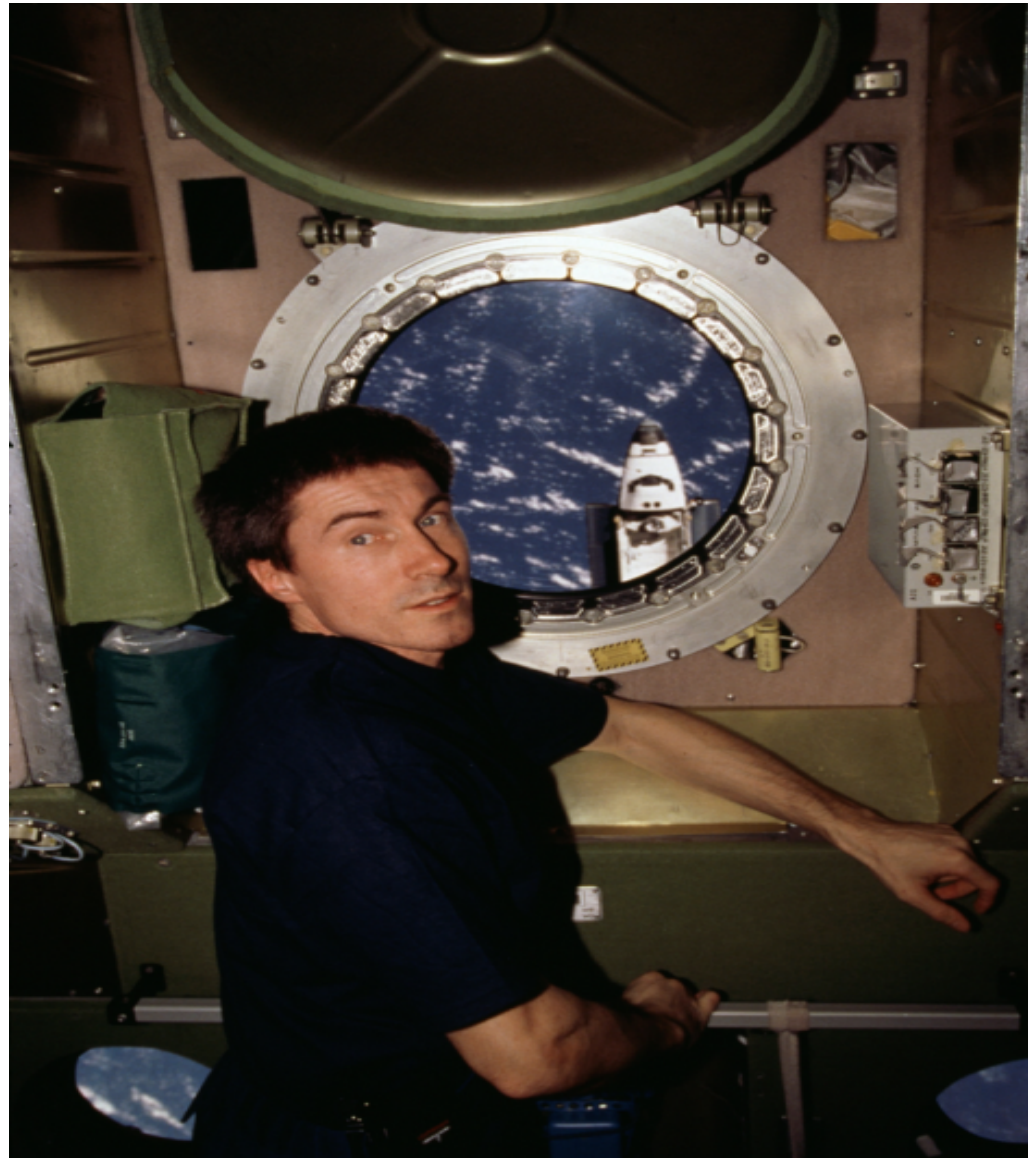
*Facility to support visual and multispectral remote sensing using Lab Optical Window*



# Windows on the Earth



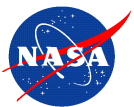
Service Module Window  
40-cm diameter  
NADIR view







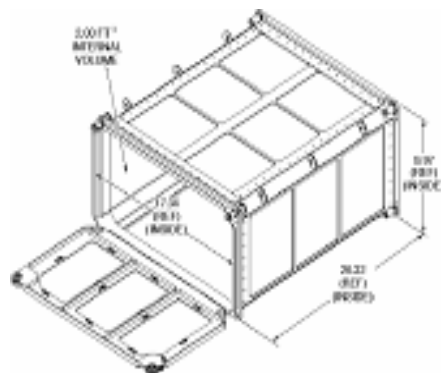




# ExPRESS Racks *(Expedite the Processing of Experiments for SpaceStation)*



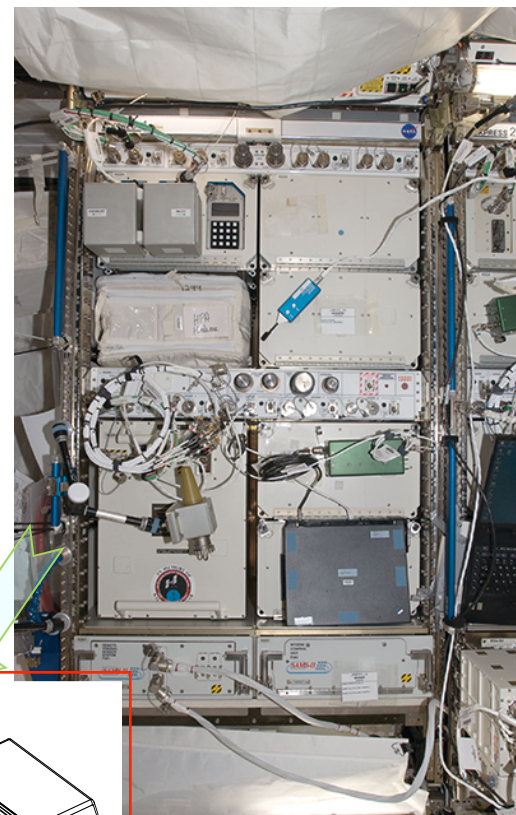
## Middeck Locker



### Features

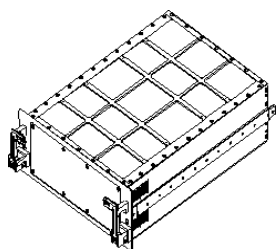
- 4 rear captive fastener attachments
- Friction hinge
- Dual door locks
- Installation tool guides on 4 corners
- Weight – 12 lbs

*Sub Rack size payload capability with standard utilities such as power, data, cooling and gases*



**ExPRESS Rack**

## International Sub rack Interface Standard Drawer



### Features

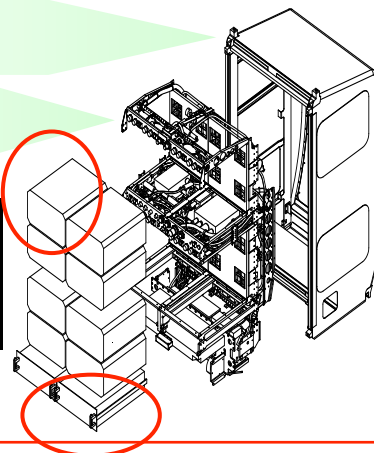
- 4 PU (Panel Unit)
- Blind Connectors
- Locking Handles
- Weight – 27 lbs
- Rated to at least 37 lbs

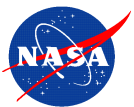
## EXPRESS 8/2 Configuration

International Standard Payload Rack

Secondary Structure & Subsystems

8/2 Payload Configuration (8 Middeck Lockers, 2 Powered ISIS Drawers)



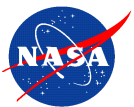


# ExPRESS Rack Resources

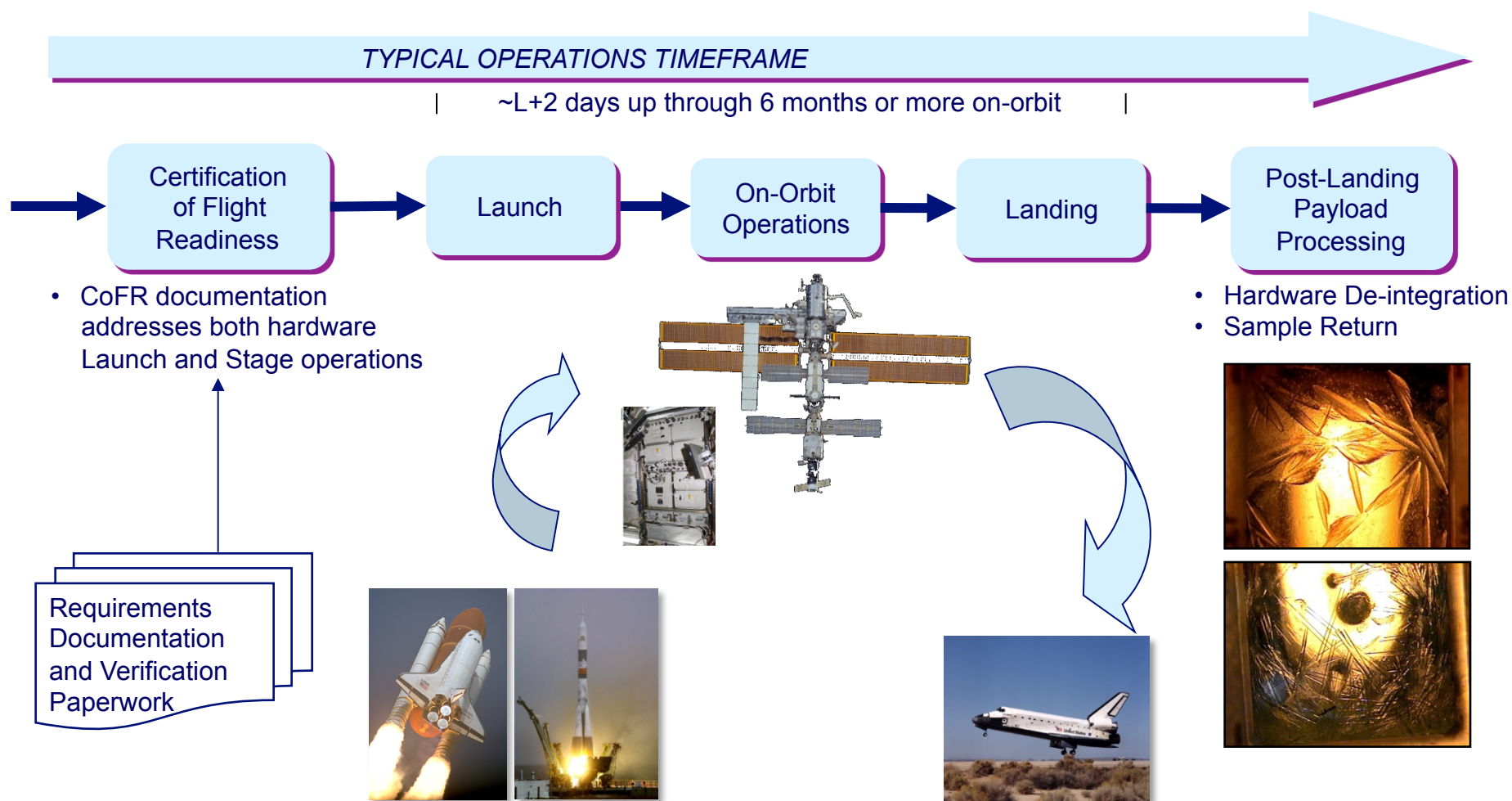
*(Expedite the Processing of Experiments for Space Station)*

<b>System</b>	Middeck Locker Locations	ISIS Drawer Locations	Rack-Level Accommodation
<b>Structural</b>	72 lbs. within cg constraints	64 lbs. within cg constraints	8 Mid deck Lockers 2 ISIS Drawers (4 Panel Unit)
<b>Power</b>	28 Vdc, 0 – 500 W	28 Vdc, 0 – 500 W	2000 Watts 28Vdc power
<b>Air Cooling</b>	≤ 200 Watts	<100 Watts	1200 Watts
<b>Thermal Control System Water Cooling</b>	500 Watts (2 positions per rack)	500 Watts (2 positions per rack)	2 positions per rack
<b>Command and Data Handling</b>	RS422      Analog Ethernet    5 Vdc Discrete	RS422      Analog Ethernet    5 Vdc Discrete	RS422      Analog Ethernet    5 Vdc Discrete
<b>Video</b>	NTSC/RS170A	NTSC/RS170A	NTSC/RS170A
<b>Vacuum Exhaust System</b>	1 payload interface per rack	1 payload interface per rack	1 payload interface per rack
<b>Nitrogen</b>	1 payload interface per rack	1 payload interface per rack	1 payload interface per rack

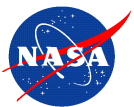




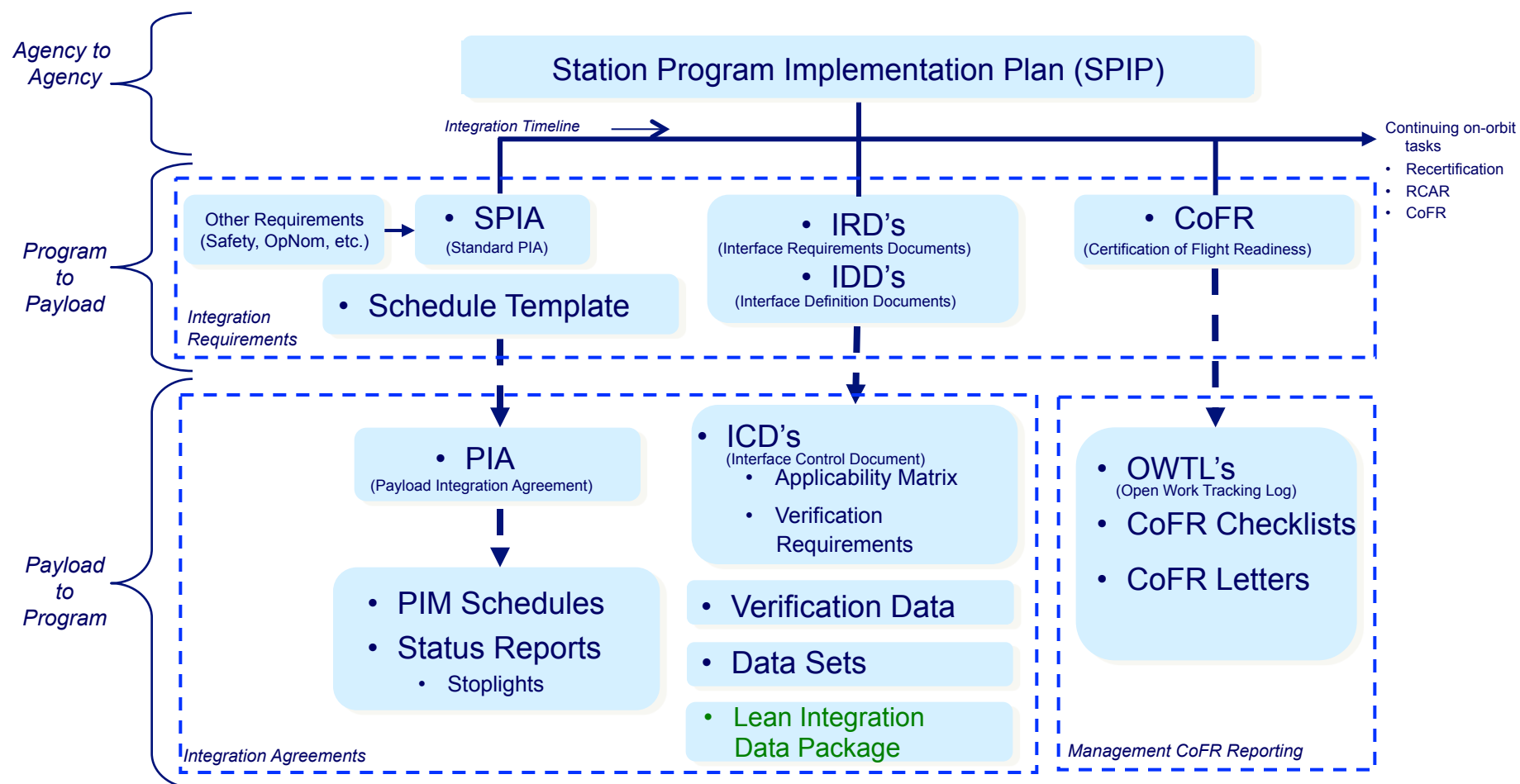
# Operations Timeframe Overview







# ISS Requirements & Agreements





# ISS Requirements & Agreements

- Requirements ensure safety, interface, and operations compatibility

## Safety Requirements Documents

- NSTS 1700.7B, "Safety Policy and Requirements for Payloads using the Space Transportation System"
- NSTS 1700.7B, ISS Addendum, "Safety Policy and Requirements for Payloads Using the International Space Station"
- NSTS/ISS 13830, "Payload Safety Review and Data Submittal Requirements for Payloads Using the ISS"
- NSTS/ISS 18798, "Interpretations of NSTS/ISS Payload Safety Requirements"
- KHB 1700.7, "Space Shuttle Ground Safety Handbook"
- SSP 52005, "Payload Flight Equipment Requirements and Guidelines for Safety-Critical Structures"
- SSP 57025, "ISS Payload Interface System Fault Tolerance Document"

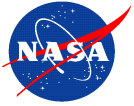
## Standard Requirements Documents (partial listing)

- SSP 52000-PDS, "Payload Data Sets Blank Book"
- SSP 52054, "ISS Program Payloads Certification of Flight Readiness Implementation Plan, Generic"
- SSP 57000, "Pressurized Payloads Interface Requirements Document"
- SSP 57003, "Attached Payload Interface Requirements Document"
- SSP 57061, "Standard Payload Integration Agreement for Attached Payloads"
- SSP 57072, "Standard Payload Integration Agreement for Pressurized, Small, and ExPRESS/WORF Rack Payloads"

• IP requirements also exist for integration into partner modules, elements, or facilities

## Joint Agreements are required in the following disciplines

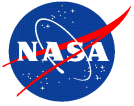
- |   |   |                        |
|---|---|------------------------|
| • Safety Requirements                       | • Command and Data Downlink Requirements    | • Ground Data Services |
| • Physical Interface Requirements           | • Operational Requirements                  | • EVA/EVR Requirements |
| • Human Factors and Labeling Requirements   | • Crew Training Requirements                |                        |
| • Electrical/Thermal Interface Requirements | • Transportation to/from Orbit Requirements |                        |



# References

---

- **ISS Program Scientist Toolbox:** <http://iss-science.jsc.nasa.gov/index.cfm>
- **ISS National Laboratory Office:**  
[http://www.nasa.gov/mission\\_pages/station/research/nlab/index.html](http://www.nasa.gov/mission_pages/station/research/nlab/index.html)
- **Advanced Avionics Development Office:**  
<http://iss-www.jsc.nasa.gov/nwo/avionics/aado/home/web/>
- **Attached Payload Interface Requirements Document, SSP 57003**
- **FRAM (ELC) Attached Payload Launch Vehicle IRD, SSP 57012**
- **ATV-2 Cargo Summary (24 Sep 2009)**
- **HII Transfer Vehicle Cargo IRD, HTV-CG-001 Rev D**
- **Requirements for International Partner Cargo Transported On Russian Progress and Soyuz Vehicles, П32928-103**
- **Cygnus Fact Sheet (Orbital, 2009)**
- **JEM EF Attached Payload Accommodation Handbook, NASDA-ESPC-2857B\_Cargo IRD**
- **Columbus EF Payload Accommodations, COL-RIBRE-SPE-0165-1C\_Columbus External Payloads IRD**



# Acronyms

---

ACES	Atomic Clock Ensemble in Space
AMS	Alpha Magnetic Spectrometer
ASI	Italian Space Agency
ASIM	Atmospheric Space Interactions Monitor
ATA	Ammonia Tank Assembly
BCDU	Battery Charge Discharge Unit
CALET	Calorimetric Electron Telescope
C&DH	Command and Data Handling
CEF	Columbus Exposed Facility
CEPA	Columbus External Payload Adapter
CMG	Control Moment(um) Gyro(scope)
COL-EPF	Columbus Exposed Payload Facility
CSA	Canadian Space Agency
CTC	Cargo Transport Container
DPP	Dextre Pointing Package
ELC	External Logistics Carrier
ELM-ES	Experiment Logistics Module-Exposed Section
ELM-PS	Experiment Logistics Module – Pressurized Section
EF	Exposed Facility
EFU	Exposed Facility Unit
EPF	Exposed Payload Facility
EPMP	Exposed Pallet – Multi-Purpose
ESA	European Space Agency
EuTEF	European Technology Exposure Facility
EVA	Extravehicular Activity
EVR	Extravehicular Robotics
ExPA	EXPRESS Pallet Adapter





## Acronyms (*Continued*)

---

FHRC	Flex Hose Rotary Coupler
FOV	Field of View
FSE	Flight Support Equipment
HPGT	High Pressure Gas Tank
HREP	Hyperspectral Imager for the Coastal Ocean (HICO)/Remote Atmospheric and Ionospheric Detection System
(RAIDS)	Experiment Payload
HRS	Heat Rejection Subsystem
HTV	H-II Transfer Vehicle (Japanese resupply vehicle)
ICS-EF	Inter-Satellite Communication System – Exposed Facility
ISS	International Space Station
JAXA	Japan Aerospace Exploration Agency
JEM	Japanese Experiment Module
JEM-EF	Japanese Experimental Module-Exposed Facility
JEM-PM	Japanese Experimental Module-Pressurized Module
Kg	kilogram
LAN	Local Area Network
LEE	Latching End EffectorMAXI Monitor All-sky X-ray Image
MCE	Multi-mission Consolidated Equipment
MIM	Multi-Increment Manifest
MiPROM	Multi-Increment Payload Resupply and Outfitting Manifest
MISSE	Materials International Space Station Experiment
NASA	National Aeronautics and Space Administration
NTA	Nitrogen Tank Assembly
ODAR	Obsolescence Driven Avionics Re-Design
OPALS	Optical Planetary Access Link for Space Station
PCU	Plasma Contactor Unit
PFRAM	Passive Flight Releasable Attach Mechanism



## Acronyms (*Continued*)

---

PIU	Power Interface Unit
P/L	Payload
PRELSE	Platform for Retrievable Experiments in a Leo Space Environment
R2D2	Robotic Refueling Dexterous Demonstration using Dextre
RMS	Remote Manipulator System
SAGE III /Hexapod	Stratospheric Aerosol and Gas Experiment III w/ Hexapod
SARJ	Solar Array Rotary Joint
SASA	S-Band Antenna Support Assembly Testbed
SCAN	Space Communication And Navigation Testbed
SDN	Starboard Deck Nadir
SDX	Starboard Deck X-Direction
SEDA	Space Environmental Data Acquisition Equipment
SMILES	Superconducting Sub-Millimeter Wave Limb Emission Sounder
SOLAR	Solar Observatory Grouping
SOX	Starboard Overhead X-Direction
SOZ	Starboard Overhead Zenith
SPDM	Special Purpose Dexterous Manipulator
Stbd	Starboard
Sx	SpaceX (US commercial resupply vehicle)
TBD	To Be Determined
TBR	To Be Resolved
TEA	Torque Equilibrium Attitude
TUS-RA	Trailing Umbilical System-Reel Assembly
ULF	Utilization & Logistics Flight
U.S.	United States
USOS	U.S. Operational Segment